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Recorder of the American Surgical Association

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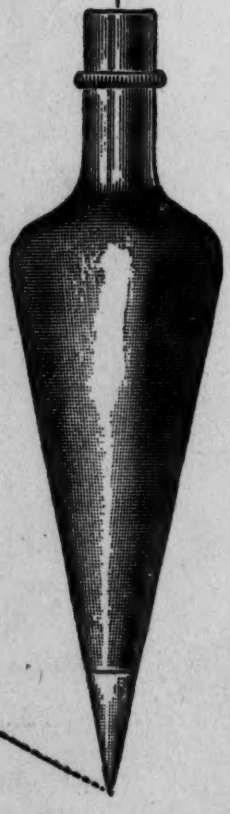

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PRESIDENTIAL ADDRESS

TREATMENT OF FRACTURES*

WILLIAM DARRACH, M.D.

NEW YORK CITY, N. Y.

A FRACTURE PATIENT is an individual whose normal activities, both vocational and avocational, have been interrupted by an injury. This injury has broken one or more bones. The damage is rarely limited to the bone. Associated soft-part injuries are often of greater importance and need more careful attention than the fracture itself. A fracture of the base of the skull does little harm in itself but the associated hemorrhage may be fatal. A fractured spine requires correction of the deformity and rest during healing but it is the associated cord injury that causes the most serious results. A supracondylar fracture of the humerus is an annoying interruption of a child's normal activities but if a Volkmann's ischemic paralysis develops, perhaps as a result of medical carelessness or ignorance, he may be permanently crippled. A comminuted fracture of the femur may take months to get bony union but even if it heals with but little deformity, it will not be very useful if the patient has a stiff knee and hip. The treatment of fractures involves more than looking after the broken bone.

In considering these associated injuries it is well to differentiate between the primary lesions occurring in connection with the accident and the secondary lesions which occur during transportation, examination and treatment. Not much can be done to prevent the primary damage but a great deal can be accomplished in reducing the secondary damage to a minimum. When a bone is broken and the fragments displaced the periosteum is torn and the

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overlying muscles, tendons, fascial planes, nerves and blood vessels, are injured more or less by the traumatizing force and the sharp margins of the bone fragments. Hemorrhage occurs from the bone ends and the lacerated tissues. The blood extravasates into and between muscles and along fascial planes with resulting swelling and tension. Edema follows within the hour, increasing the swelling and tension and interfering with the circulation and the elasticity of the muscles.

Under secondary traumata are included the additional injuries caused during transportation without protective splinting, to the hospital, to and from the Roentgenologic Department, ward or operating room, rough handling during examination, carelessly planned and repeated, manipulative attempts at reduction. Most surgical procedures are two-edged swords and do harm as well as good. The art of surgery lies in doing as much good and as little harm as possible by these procedures. Tight bandages, localized pressure from splints, prolonged immobilization and passive movements contribute to these additional injuries. Most of these secondary traumata affect the soft-parts. Many of them can be avoided or at least minimized. Unless proper attention is paid to these soft-part injuries the main object of treatment will be defeated. This object is to restore to normal, as far as possible and as quickly as possible, not only the anatomy of the bone but the physiology of the extremity and of the patient himself.

In treating patients with fractures our plan of action should be based on full appreciation of the details of the individual problem rather than by following blindly a certain procedure laid down for the average case. This can be illustrated by two cases which came to our own Clinic. A man came in who had fallen on his outstretched hand and the intern on duty in the accident ward suspected a Colles' fracture and sent him to the Roentgenologic Department. A little later he telephoned and was told that the man did have a Colles' fracture. The intern had been taught that the way to reduce the typical Colles' was to give an anesthetic, exert steady traction in order to disengage the fragments and then to press forward the lower fragment and adduct the wrist. This was carried out with vigor and enthusiasm and the patient splinted and sent for additional films. Later, when the intern inspected these he thought they must be the prereduction films, except that they showed a plaster splint, whereas the original ones did not. The original films showed a fracture through the distal radius with no displacement, whereas the ones taken after his efforts showed a marked forward displacement which was rather difficult to correct. The following week a similar incident happened when another eager intern converted a complicated fracture of the ankle without displacement into one which was rather difficult to get back into its original state.

The plan of action should be aimed at certain definite objectives after weighing all the factors involved. Just how these objectives are reached is of minor importance provided the plan is wisely made and carefully carried out. Splints, weights, pulleys, pins and other gadgets are means to an end and will

be used successfully only when that end is wisely and carefully planned. The objectives can be considered under five headings: (1) reduction of secondary traumata to a minimum; (2) sufficient restoration of normal form to meet the requirements of the specific case; (3) rest for the fractured part during the healing process; (4) maintenance and restoration of function of the soft parts; and (5) morale of the patient.

1. *Reduction of Secondary Traumata to a Minimum:* The ideal arrangement, if a patient is to break his leg, is to do this in a hospital where he may obtain immediately the services of a well-trained doctor who has at his disposal all of the needful accessories. Unfortunately, this rarely happens. The period of disability and the perfection of functional return is often determined more by what happens after the original injury than by the character of the accident. A great deal has been accomplished in recent years in educating the public in the proper first-aid handling of injured people. The subcommittee on transportation of the American College of Surgeons, under the chairmanship of Robert Kennedy deserves a great deal of credit for this accomplishment. The education of members of the police and fire departments in first-aid work, similar instructions given to the Boy Scouts, the many courses given under the American Red Cross have been well worth while. Over ten million Red Cross certificates for first-aid instruction have been issued since 1910, three million six hundred in 1942. The need for equipping ambulances with proper splints and the instruction of drivers in their use is being recognized more widely. The subject has been taken up by the two national associations of morticians, as they handle most of the ambulances west of the Alleghenies. Railway surgeons are doing their part. Much has been done but more is required and the gospel of "splint 'em where they lie" should be preached at every opportunity.

Two examples of first-aid treatment may be cited. A Columbia freshman football player was struck by a blocking back and fell. He said he had broken his thigh. The doctor who attends all practice periods and games came out with a Thomas splint and a stretcher, found the boy was right, applied the splint and carried him to the hospital. He was found to have a transverse fracture of the femur with almost no displacement and minimal soft-part damage. With simple treatment he was restored to normal and played three years of varsity football. A few days later another boy was brought in who had received a similar injury in a sand lot game. His own diagnosis was the same but he was helped to his feet only to collapse again so he was picked up, one man carrying his shoulders and another his middle, while the injured leg dangled. Imagine what was taking place in that thigh as the leg swung to and fro. He was laid on the side lines while someone got a car, then picked up again and put in the back seat. Getting an injured or inebriated individual through a car door onto the back seat is a complicated procedure. Arriving at the hospital a splint was applied before he was lifted out but the damage was done. The sharp end of the upper fragment had torn the overlying muscles, penetrated the fascia and overlying skin

and rested in the not too sterile football clothes. The problem of repair in this case was quite different from the other case. Protection and gentle handling in transportation and examination will do much to lessen the secondary traumata.

2. *Sufficient Restoration of Normal Form to Meet the Requirements is the Second Objective:* Reduction of existing displacement should be carried out at the earliest possible moment. When this can be done before the extravasated blood and edema have infiltrated the soft-parts and reduced their pliability, simple traction in the axis of the limb will often give astonishing results even in complicated fractures. No extensive manipulations should be attempted however until a careful examination has been made, a definite procedure planned and the necessary equipment assembled. The surgeon should study the roentgenograms himself. It is not enough to learn that a fracture exists. A number of questions should be answered. Is the bone otherwise normal or is it diseased; is there any displacement of fragments, if so, what is their present relationship; what procedures will overcome that displacement with the least additional injury; when reduced how can that reduction best be maintained; is there any injury to epiphyseal plates; are there other fractures in the area shown; what structures lie in the neighborhood such as nerves and large blood vessels whose suspected injury has not been covered by the examination or should be protected in further procedures. During our study of the roentgenograms it is wise to think of the answers to the questions which the patient or his family will ask. How long will I be in the hospital? Can I go back to my old job? When can I play golf or the violin? How much will it cost, and many others.

With a thorough understanding of the problem the plan for reduction of the existing displacements and the maintenance of that reduction can then be carried out. The object is to restore anatomic form with as little additional damage as possible. Thoughtful planning and gentle efforts are indicated. Reduction can be accomplished by manipulation, by continuous traction or by open operation, alone or in combination. The displacement of fragments usually involves a certain amount of impaction or overriding which should be overcome before any attempt is made to correct a lateral shift. This is accomplished by manual traction, initiated gently and slowly increased until the fragments have become disengaged. No attempt must be made to correct the alignment until this has been accomplished. If steady, manual traction is maintained for several minutes it is surprising how often this will be sufficient. In over 500 shoulder dislocations simple, steady traction has proved successful without the more complicated and damaging Kocher procedure in over 90 per cent of the cases.

Is exact anatomic replacement of fragments necessary? The answer frequently is no. The decision as to whether a reduction is satisfactory or not is often difficult to make. Many factors are involved. In children, especially in the first year or so, shaft fractures, whose roentgenograms would shock any jury, may often be left to nature with impunity. The main

questions are, how much will a given deformity interfere with what its owner wants or has to do; will the additional damage caused by further attempts at reduction outweigh the advantages of such attempts. A violin player needs complete supination in his left forearm. A piano player or stenographer requires complete pronation. A bricklayer or plasterer has to get his hands well above the horizontal. A mechanic or carpenter may be greatly handicapped by painful wrist rotation. One patient developed an occasional momentary pain in his thigh 23 years after I plated his femur, a trifling affair for most people. However, he was a structural iron worker then working on the 60th floor of the Empire State Building. As he said, "you only come down once in our job." An unstable ankle mortise often leads later on to an incapacitating traumatic arthritis. In epiphyseal injuries prolonged or repeated or operative attempts at correction increase the danger of growth disturbance. Sometimes a deformity needs correction although it does not affect the function of the part. Depressed fractures of the malar bone and prominent clavicles in younger females are examples.

Satisfactory reductions can be obtained best if done within a few hours of the accident. Fractures are emergencies and should not be allowed to wait until the next day or a more convenient time. Hospitals should have 24-hour and seven-day roentgenograms and emergency facilities. Reductions should be planned to meet the specific requirements of the individual case. They should be carried out as gently as possible to minimize the additional trauma. Before attempting reduction the means for maintaining that reduction should be ready at hand. An exception to the rule of immediate reduction may be indicated when a case comes late, with marked swelling. Rest, elevation, local heat for a day or so will make the reduction simpler and more efficient.

3. *Rest for the Injured Bone Hastens Healing.* The tissues of bone repair in its early stages are fragile. Each time this granulation tissue is subjected to shifts in position, fresh hemorrhage occurs and the orderly development of stronger tissue is unduly delayed. However, it would be unwise to state that rigid fixation is necessary for solid bony union. An extreme example of this occurred during the Passchendael Campaign in 1917. A British Tommy was caught in No Man's Land with a machine gun wound through his thigh and a shattered femur. He took refuge in a shell hole and lived for awhile on his own tin rations and those of several buddies who no longer needed theirs. Later, he occasionally crawled out at night to collect rations from others lying about. Finally, an advance was made and he was brought in several weeks later. Roentgenograms showed a beautiful "wipe-joint" callus, firm union and surprisingly little deformity. No splints, no traction, no physiotherapy. The same thing is illustrated by that thoroughly irrational, but surprisingly successful, method of treating humeral shafts by the so-called "hanging plaster" which does not immobilize but does provide continuous traction.

4. *The Impairment of Function of the Soft-parts is Due, in Part, to the Injuries Associated with the Original Injury and the Early Handling:* Lacer-

ation and contusion of periosteum, muscles, fascia, tendons, blood vessels, nerves, and perhaps the skin, require their own processes of repair. This is impeded by the subsequent infiltration of blood and lymph. The latter also, by increased tension, leads to circulatory impairment. Further slowing of the venous and lymphatic return comes from encircling bandages and pressure of splints. Prolonged disuse leads to atony and atrophy of muscle tissue and stiffness of joints. Since the repair of tissue, whether bone or soft-parts depends so much on circulatory efficiency, every means should be adopted to maintain this at its optimum level. Among such means are: a position of the injured part which will avoid fighting gravity; lack of constriction; local heat; gentle massage and perhaps sympathetic blocks. The most valuable aid in helping circulation, as well as in restoring the power and control of muscles and the range of motion in joints, is active motion. These movements may be guided and protected by an attendant but must be done by the patient himself. Passive movements which cause pain mean fresh injury, tearing of tissue, and do more harm than good. Occasionally, in protracted cases, where other means have failed, a single manipulation of a joint under anesthesia may be necessary.

When a satisfactory position has been obtained this can be maintained in several ways. Splints of various materials and design protect against additional injury and afford rest during the process of repair. The metal splints on the market are designed to fit the average case and rarely fit the individual. They are useful only in emergencies. The most frequently used splint is made of plaster of paris, either circular or molded. This will probably be partly superseded soon by some of the newer plastic materials which are lighter and are not opaque in roentgenograms. At present, most of them are rather slow in drying. Position can be maintained by continuous traction, usually in suspension. This is applied either by adhesive strips to the skin or by penetrating wires or pins (skeletal). Wires or pins which penetrate the bone and protrude on the outside can either be incorporated in circular plaster or attached to an outside bar, such as the Stader, Anderson, or Haynes apparatus. Position can be maintained by internal fixation using metal screws with or without plates. Each of these methods has its advantages and disadvantages. The various types of splints offer good immobilization of the bone but impair the circulation and interfere with active movements and other measures to hasten soft-part repair. Continuous traction offers less rigid fixation but avoids pressure and frequently will permit earlier active use. The combination of pins and plaster prevents shortening and rotation and is better than plaster alone. It is especially useful in oblique and comminuted fractures. Although the frequency and severity of infection of the bone and soft-parts following the use of pins and wires which protrude through the skin have proved to be less than was predicted, such complications do occur with undesirable frequency.

If it has been decided to use continuous, mechanical traction both to obtain and maintain reduction, several points should be borne in mind. The

line of pull should be in the axis of the proximal fragment. The amount of force required will depend largely on the time elapsed since the injury. With the increasing resistance due to soft-part changes, the amount of pull required increases as time goes on. Too often does the increase in force applied prove to be too little and too late. If traction alone proves unsuccessful, there is no reason why it cannot be aided by manipulation. After reduction has been accomplished, the force required to maintain the position is decreased as over-pull, with separation of fragments favors delayed or nonunion. Skeletal traction is more efficient than skin traction. The latter is to be avoided in elderly people where the wasting of subcutaneous tissue and the flabbiness of the skin make the pull less efficient and may result in tearing of the skin Traction in suspension requires hospitalization. Moreover, it requires 24-hour care by personnel trained in its use. It cannot be applied and then neglected as it needs constant care and adjustment. Unless this is available it should not be used. Open reduction and internal fixation followed by rest in suspension can provide satisfactory immobilization and unlimited treatment of soft-part damage. The risk of infection, however, is a real one.

In some fractures reduction can be obtained and maintained only by open methods. Examples are fractures of the patella or olecranon with wide separation. In this group, operation is really one of necessity. A second group includes cases where it is recognized from the nature of the injury that either immobilization by splints or the use of traction will result in considerable impairment of function or prolonged disability. If either or both of these can be lessened materially by open reduction and internal fixation, that should be the method of choice. This includes many oblique or comminuted fractures and sometimes those where the fracture lines extend into joint surfaces. Other cases present themselves where immobilization in splints or traction offers an excellent chance of completely satisfactory results, yet open reduction and internal fixation may be desirable if they can reduce materially the period of disability. The time element is often of great importance to some individuals. Open reduction and internal fixation should not be undertaken by anyone who is not qualified to carry out the necessary details. These include unusually careful technic, an adequate armamentarium and attention to the mechanical details of application. If these are neglected, results may be shockingly bad. Restoration of muscle, joint and circulatory function depend to a great extent on early use. The establishment of priorities between these two contradictory objectives adds to the fascination of fracture treatment. Methods which permit the maximum of both are desirable.

The choice of procedure is determined by many factors, the age of the patient, the details of the individual case and prognosis as to time involved and amount of eventual disability, as well as the training, facilities and aptitudes of the surgeon. Long arguments can be made for relative advantages of the dry fly, wet fly and old fashioned worm, but they all catch

trout. The method of choice in a given case is the one by which the individual surgeon can solve best the problems of that case under existing conditions.

5. *Another Objective Concerns the Morale of the Patient:* Few surgical conditions require more coöperation of the patient than fractures. All the surgeon can do is to make the conditions of repair as simple as possible. No splint, nor Balkan frame, nor plate, nor screw will make a bone unite nor will they restore to full activity the injured structures which carry out the functions of that extremity. The restoration of soft-part function is the problem where the patient can be of greatest help by his coöperation in carrying out procedures with this end in view. A patient was recently referred to me because of a completely useless hand. He applied to a hospital but being a compensation case was turned over to a member of the staff who obtained a very satisfactory reduction of a simple Colles' fracture. A splint was applied and he was told to report to the doctor's office in three weeks. At this time the splint was removed and he was given baking, massage and diathermy, the splint replaced and his forearm went back into a sling. When I saw him I asked him how often this had been repeated and he said three times a week. He had not seen the doctor since the original reduction. The treatments were carried out by the office nurse. Between visits he had continued to carry his arm in a sling giving it complete rest. This had been going on for a year and a half. His elbow, wrist, fingers showed no appreciable motion and the status of his muscles can easily be imagined. Although the compensation laws have done much to relieve the financial burden of the injured workman, the concomitant evils almost equal those of the Volstead Law. Most of these patients are not malingerers but the idea that someone else is responsible for their care has relieved them of all personal responsibility and their attitude towards their recovery is quite impersonal. Unless these patients can be made to understand that it is their own responsibility to carry out instructions, much time will be lost. The importance of gaining their confidence at the start of the treatment cannot be over-emphasized. The latter is especially true of children. You can lie to a child only once for then he will never trust you again. He, therefore, should be warned ahead of time of any painful procedures. Even adults share the same reaction. A man with a family who has adjusted his daily life to a more or less fixed income and meets with a sudden accident, needs a good deal of moral support to carry him through the period which is often so discouraging and may be disasterous. The period of rehabilitation, after the splints have been removed but before he can resume normal activities, is often greatly neglected. The work done in Army and Navy hospitals along this line has been an excellent example of what can be done. Occupational therapy should not only create diversion for a bored patient but can be made of real therapeutic value in hastening the return of flabby and awkward muscles and stiff joints.

Compound Fractures. In the treatment of compound fractures, all the problems of closed fractures are encountered but, in addition to these, the

additional factor of infection is introduced. The tremendous number of compound fractures handled by the armed forces in recent years and the efficient manner in which they have been treated has thrown much light on this problem. This experience has, in the main, emphasized the truth of the general principles of treatment already accepted. It has also helped to clarify some unsolved details. Among the principles emphasized are the importance of protective first aid in reducing secondary traumata and the spread of contamination; the great value of early operative removal of foreign material and devitalized tissue with control of hemorrhage—débridement; the wisdom of early reduction of deformity; the need for immobilization, as frequent change in position of bone fragments not only impairs healing but spreads infection; and infrequency of subsequent dressings.

One of the causes of shock is the absorption of toxic products resulting from traumatized tissue. An important factor in the control of shock is the early reduction of the supply of such products. It is being realized more and more that early débridement and immobilization is an essential part of shock treatment. If the patient has a palpable pulse and appreciable blood pressure, he should be taken to the operating room without delay and the usual shock procedures carried out during the operation. When this is done his condition not only improves during operation but the secondary shock after delayed operation is usually avoided.

The effect of the various forms of chemotherapy on the control of infection has been disappointing. It may be stated strongly that no form of chemotherapy offers a substitute for early, thorough surgical treatment. It is doubtful if the local use does more good than harm. General use undoubtedly decreases the danger of spreading and general sepsis.

There is still divergence of opinion regarding closure of the operative wound. Primary closure after an early, thorough, efficient operation will undoubtedly hasten repair and reduce the amount of after care necessary. Primary closure is being carried out rather extensively and is proving successful in a high percentage of cases. Its success depends on the amount and character of contamination, the time at which the operative procedure is carried out, the amount of damage to tissues, the control of hemorrhage and the avoidance of any tension in the wound. When unsuccessful, however, primary closure may give disturbing if not disasterous results. It is believed by many that the safer and wiser method is to adopt some type of secondary closure but without too much delay.

SUMMARY

A fracture patient is a human being whose normal activities have been interrupted by an injury. This injury not only breaks a bone but causes damage to soft-parts. The object of treatment is to return that individual to a normal state as completely and as rapidly as possible. The normal state must be considered from anatomic, functional, economic and psycho-

logic standpoints. Lack of attention to soft-part damage may lead to unnecessary delay and unsatisfactory results. In planning treatment each case must be studied as an individual problem and all the factors evaluated. Success will depend more on a correct understanding of the problem and a wise plan of action than on the methods by which that plan is carried out.

PHARYNGO-ESOPHAGEAL DIVERTICULUM: ITS MANAGEMENT AND COMPLICATIONS*

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THE SUBJECT of pharyngo-esophageal diverticulum has been discussed over the years by various authors, and the principles involved with the occurrence and with the management of this lesion have now been very well established. In spite of this fact, the number of surgeons who have had a relatively large experience with this lesion is fairly limited and it, therefore, seems to me to be of value for those who have had these experiences with this lesion to discuss them and to report the views accumulated with them.

Pharyngo-esophageal diverticula are known to originate quite consistently at the same level, that is the junction of the esophagus with the pharynx. They are known to be related to the anatomy of this point and are brought about by the relationship between the inferior constrictor muscle and the obliquely passing fibers of the cricopharyngei as they descend upon the posterior wall of the esophagus to become longitudinal.

As may be seen in the diagrammatic illustration (Fig. 1), the obliquely passing fibers of the cricopharyngei form a triangular space bounded above by the lowest fibers of the inferior constrictor and on each side by the oblique fibers of the cricopharyngei. This is known as the pharyngeal dimple and is the weak place in the posterior wall at the pharyngo-esophageal junction.

The neuromuscular coördination which brings about propulsion of food from the pharynx into the esophagus acts normally when with contraction of the constrictors the cricopharyngei relax to permit propelled food to pass into the esophagus. When there is any incoördination in this neuromuscular effort, the pressure from the constrictors and the obstruction below from the unrelaxed cricopharyngei will obviously result in a bulge at the point known as the pharyngeal dimple (see Fig 2 *a*, the first stage of the esophageal diverticulum).

As this coördination continues to produce recurring pressure upon this weak point, what was originally a bulge soon becomes a sac since the bulging pharyngeal wall is made up, in this, a false diverticulum, only of mucosa and submucosa and is covered by but a few of the remaining fibers of the cricopharyngei.

As the bulge converts itself into a sac the course of the sac as it enlarges is in the downward direction under the few enveloping fibers of the cricopharyngei, and as the sac becomes more frequently distended with food, and has for its walls only the readily stretched mucosa and submucosa, this sac

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progressively increases in size until it is in a dependent position parallel with the esophagus, with a true sac body, a true neck, and a small aperture in the midline opening into the true esophagus. This is well illustrated by Figure 2 *b*, the second stage of the development of a pulsion pharyngo-esophageal diverticulum.

With further passing of time and the accumulation of greater amounts of food within the sac and so greater distention of the sac, together with the effect of ascending and descending with swallowing, further enlargement of the sac is in the downward direction into the superior mediastinum until the size of the sac can reach good-sized proportions, illustrated as the third and final stage of the development of pharyngo-esophageal diverticulum (Figs. 2 *c* and 10).

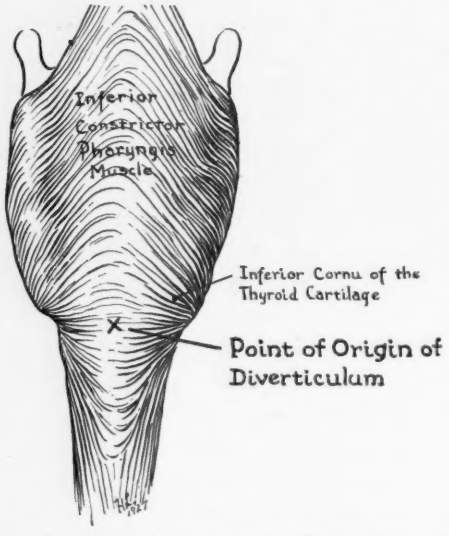

FIG. 1.—Diagrammatic illustration of anatomy at the point of origin of the diverticulum.

We have learned from this experience with these cases that each stage of this disease has with it a group of symptoms brought about by the stage of development of the diverticulum. For example, in stage 1 (Fig. 2 *a*), that is, when there is merely a bulge, there are no symptoms except those related to the occasional lodging of a dry piece of bread or cereal within this bulge, which results in recurring attempts of the patient to dislodge it by hawking. There are no other symptoms related to this stage of the diverticulum, and because there is no neck to the sac and it is only a bulge, operation is neither necessary nor advisable.

The symptoms related to the second stage (Fig. 2 *b*) are merely those associated with the presence of a sac and to the fact that this sac constantly has contents made up of food mixed with air and mucus. It is to be remembered that an esophageal diverticulum is a sac placed in front of the prevertebral fascia and behind the pretracheal fascia, that it ascends and descends with swallowing, and that its contents are variable in amount so that the degree of distention within the sac is variable. It is to be recalled also that the sac rests posteriorly upon a rigid structure, the vertebral bodies, and is covered in front by the sternomastoid, omohyoid, sternothyroid, and the overlying thyroid gland. With this anatomy in mind, one can realize how, with changes in position of the neck and chin, there are changes in pressure on the fluid and air filled sac by these overlying structures against the nonresistant posterior boundary. This produces unpredictable expulsion of food and mucus which can come up into the mouth anytime during the day or night. In addition to

this, as a result of pressure upon the sac as it ascends and descends with swallowing, the mixture of air with food and mucus can produce gurgling noises which are audible to friends of the patient who eat at the table with him and which at times occasion embarrassment for the patient, since inquiries are frequently made as to the causes of obvious noises in the patient's throat as he swallows.

Since with change in position the contents of the sac can be unexpectedly expelled into the pharynx, it is also obvious that changes in position at night

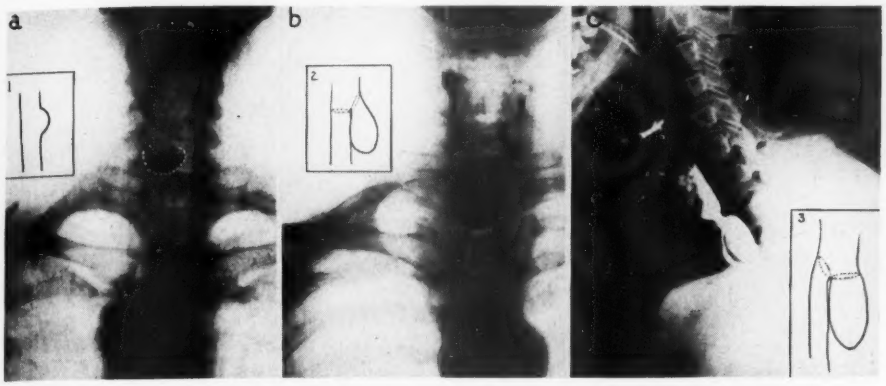

FIG. 2.—*a*, Note that this is the first stage of esophageal diverticulum, shown diagrammatically by the bulge in insert 1 and by the roentgenogram. Note absence of any sac.

b, In this illustration is shown the second stage of esophageal diverticulum with a true sac. Note that the opening into the esophagus at this stage is longitudinal while the opening into the sac is lateral.

c, This illustration graphically demonstrates why obstructive symptoms occur at the third stage of development of a diverticulum. Note that the direct opening is now into the sac of the esophagus, its opening being transverse, while the opening into the true esophagus is now lateral (see insert 3). The thin stream of barium can be seen overflowing from the sac through the laterally placed opening into the true esophagus.

with the head and neck at various angles on the pillow, can bring about unpredictable expulsion of the sac contents into the pharynx with occasional inspissation of the contents, strangulation, and the danger of lung abscess.

Many of these patients have come to us seeking operation because of some of these above stated features, because they are so embarrassed with the noise they make in their throat when swallowing, because they have so frequently been awakened at night by the expulsion of food that it interferes with their sleep, and because in four cases the inspissation of food has produced lung abscesses.

All of the symptoms associated with the second stage of the development of this condition just spoken of can be associated with the third stage (Fig. 2 *c*) of the development of pharyngo-esophageal diverticulum, that is, the stage with the large sac. This stage is, however, distinguished by the fact that it is only at this stage that obstructive symptoms occur. I wish particularly to discuss the cause of obstruction at this stage in order that anyone dealing with a patient with a large pharyngo-esophageal diverticulum of the third

stage will understand its cause and its management, particularly as relates to attempting to pass an esophagoscope or attempting to introduce a feeding tube preoperatively before the sac has been freed and completely dissected and especially because of the danger of attempting to pass a bougie at this stage.

When we first began to operate upon patients with large esophageal diverticula who had obstruction, it was my impression that the obstruction was

FIG. 3.—A further excellent illustration of stage 2. Note the well formed sac with a neck, the lateral opening and the true esophagus outlined by dots.

probably due to the pressure of the very large, filled sac against the lateral esophagus. It was some time before I realized that this was not the case.

In stage two when the sac is first developed and is of only moderate size, it will be seen, as illustrated in Figures 2 *b* and 3, that the opening into the sac is on the lateral wall of the esophagus and that the opening into the true esophagus is in the normal transverse position. However, as this sac enlarges, and as a result of its enlargement together with the weight of its contents, descends into the mediastinum it drags the lateral wall of the esophagus down-

ward with it and, as shown in Figure 2 *c*, converts the opening into the diverticulum sac into a semitransverse one and the opening into the true esophagus into a semilateral one (Fig. 2 *c*, insert 3). As may be visualized from the diagrammatic illustration (Fig. 2 *c*, insert 3), as the sac becomes larger, more distended and its contents heavier, and as it descends farther into the mediastinum, this downward traction converts the true opening into the esophagus

FIG. 4.—Note loss of irregularity in one-fourth of the circumference of the otherwise discretely outlined sac in which malignancy was present.

not only into a semilateral one but by the traction tends to pull the two lips of the opening into the true esophagus together and convert it not into an aperture but into a slit.

I am anxious to present this viewpoint in order that in this stage attempts will not be made to pass an esophagoscope or to introduce a tube, because either the tube or the esophagoscope will pass into the sac, cannot be manipulated in the advanced cases into the lateral opening and if any pressure is persisted in, will result in perforation of the sac, as has occurred before coming to us in a few of the cases which we have seen and has been followed by serious mediastinitis. Perforation had occurred in four of the patients coming to us,

necessitating gastrostomy, drainage of the fascia planes of the neck, drainage of the mediastinum, and in one case the drainage of a mediastinal abscess by posterior mediastinotomy elsewhere before the patient came here for repair of the diverticulum.

COMPLICATIONS OF DIVERTICULUM NOT ASSOCIATED WITH SURGERY

The complications, other than those of obstruction, of esophageal diverticulum of the pulsion type not associated with the operative procedure are largely limited to the development of carcinoma in the walls of the sac of the diverticulum.

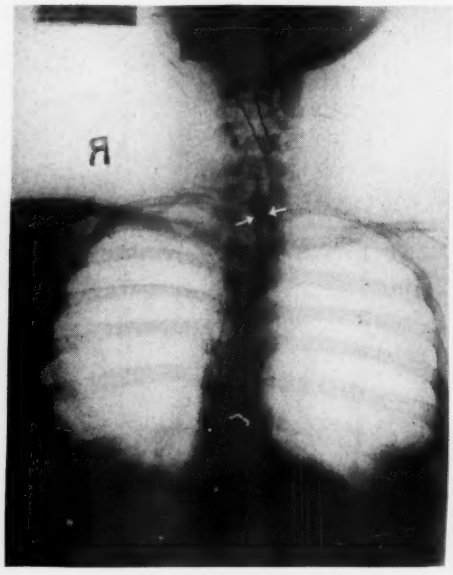

FIG. 5

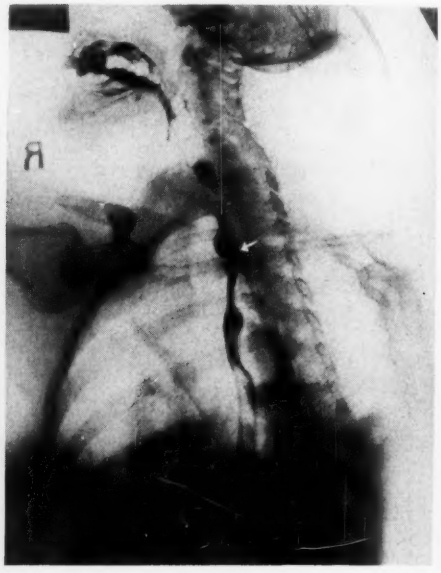

FIG. 6

FIG. 5.—This patient, whose roentgenogram is shown here, was sent to the Clinic for operation of esophageal diverticulum. Note, as shown by arrows, the escape of fluid from the lowest point. This was a high esophageal web.

FIG. 6.—The same patient as in Figure 5, shown laterally. Note the absence of the spill-over stream, which characterizes a true esophageal diverticulum, and the emergence of the barium from the lowest point. This patient was completely relieved by dilatation.

The indications of the occurrence of a possible malignancy within the sac are particularly related to the appearance of blood in the mucus expelled from the sac or a suspicion of malignancy created by the roentgenologic appearance when the outline of the sac edges are irregular. They should be, in cases uninvolved with malignancy, sharp and clear. In those patients, as shown in Figure 4, with malignancy involving the diverticulum, this outline is no longer sharp and clear but is irregular in character.

NONOPERATIVE TREATMENT

The nonoperative treatment of pulsion esophageal diverticulum consists solely of dilatation. It is of very doubtful value in stage one (Fig. 2 *a*), it is

impossible in the cases with a marked degree of obstruction in stage three (Fig. 2 *c*), and is applicable only, from a practical point of view, in stage two (Fig. 2 *b*), in which the opening into the true esophagus is completely transverse and permits the dilator or bougie to pass readily into the longitudinal esophagus and permit dilatation of the portion of the esophagus from which the diverticulum springs.

During the period when an esophageal diverticulum of this type is at the second stage, dilatation produces considerable relief by lessening obstructive symptoms. It does not, however, materially delay the increase in size of the sac, nor does it do away with the unpredictable occurrence of regurgitation, the comment-causing noises which at times occur during eating or the dangers of the inspissation of food and mucus regurgitating from the sac during the night.

It is important, I believe, to call attention to the necessity of doing the dilatations, if they are to be done, at this period, on a string previously swallowed to insure that the bougie does not pass blindly into the sac because if it does, any pressure upon it can readily perforate it.

DIFFERENTIAL DIAGNOSIS ROENTGENOLOGICALLY OF PULSION ESOPHAGEAL DIVERTICULUM

So distinctive is the roentgenogram of pulsion esophageal diverticulum that one would hardly think it possible to be mistaken as to its diagnosis. I wish particularly to warn that such is not the case. In certain cases with a high web in the esophagus (Figs. 5 and 6), in certain cases roentgen-rayed postoperatively sometime after removal of an esophageal diverticulum (Fig. 7) and in certain cases with high stricturing of the esophagus, there will be a dilatation of the esophagus above the web, scar of the previous operation or stricture, which by roentgen ray will by its spherical character lead anyone who has not had considerable experience with these into assuming that what is really only local dilatation is a true esophageal diverticulum (Fig. 8).

As will be seen in Figure 9, the distinguishing feature of a true diverticulum is the demonstration of its body, neck and the spill over of the thin barium mixture after the sac is filled into the true esophagus, which can be shown, when viewed laterally (Fig. 9), in most of the cases as a thin line running from its neck down behind the sac. In those cases in which there is only a dilatation, if this thin line be seen, it will emerge from the bottom, most dependent portion of the sac where the narrowed point is (Figs. 5, 6, 7 and 8), and on lateral view will never be seen behind the diverticulum, and representing the spill-over from the highest point of the sac.

Unless a definite body, neck and aperture into the esophagus of a suspected pulsion esophageal diverticulum (Fig. 9) can be demonstrated in the roentgenogram the patient brings with him, these sacs should be visualized under the fluoroscope, and another roentgenogram taken, particularly in the lateral position, to demonstrate that the lesion is a true diverticulum and not esophageal narrowing—the spherical dilatation as shown in Figure 8.

BEST TIME FOR OPERATION

As already stated, operation should not be done in the first stage (Fig. 2 *a*). Since there is no neck at this time, there are no symptoms of significance and the sac has not as yet so developed that it can be amputated. The most desirable time at which to operate upon a patient with an esophageal diverticulum is in the early portion of stage two (Fig. 2 *b*). At this stage the sac is small, there are no inflammatory adhesions, it has a good neck, the aperture into the esoph-

FIG. 7.—This is the dilatation above the scarring following the removal of an esophageal diverticulum. Notice the apparent appearance of a neck at the arrow but that the barium emerges from the lowest point of what appears to be the sac. This is a dilatation above the scarred esophagus.

agus is small, it is possible to dissect the sac with no great difficulty and the patient has had no obstructive symptoms to in any way seriously affect his health. In addition, at this stage the sac can be readily buried in the wound between the first and second stage of the operation and when the wound is reopened, with its small neck, ligation of the neck flush with the longitudinal esophagus can be readily accomplished, with amputation of the remaining

portion of the sac easily, quickly and with less likelihood of recurrence than exists in those cases in which the diverticulum has gone on to a large sac and with a large aperture between the sac and the true longitudinal esophagus.

If operation is carried out at the third stage when the sac is large and located within the mediastinum, the sac will, as a result of inflammatory reac-

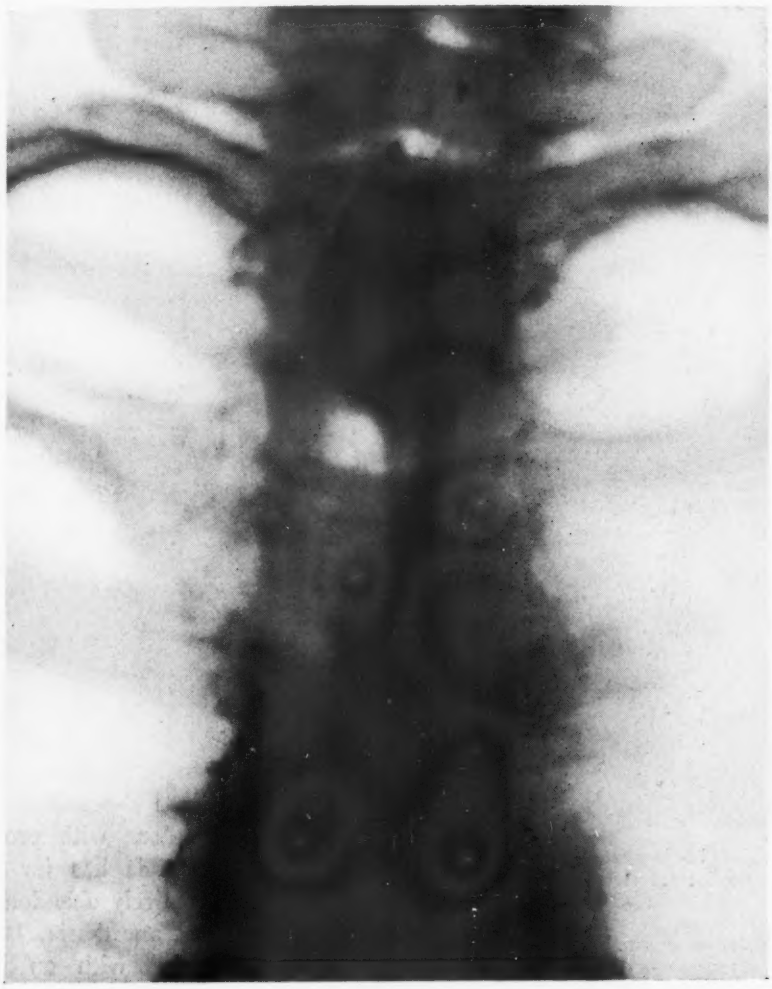

FIG. 8.—Based upon this roentgenogram, without a lateral view, this patient was operated upon for an esophageal diverticulum which proved to be only a dilatation. Had a lateral view been taken, it would have been demonstrated that there was no spill-over, as shown in Figure 9, which is a true esophageal diverticulum.

tion within the sac, occasionally be adherent in the mediastinum to the posterior aspect of the pleura. Its removal will leave a large mediastinal cavity, the sac will be so large that it will require implantation not in the wound but upon the neck (Fig. 10) and the opening into the true esophagus will be so large

that a ligature will not be as satisfactory as will suture of the neck of the diverticulum. As a result, a suture which must be done on the posterior wall to secure approximation can never be as satisfactory as one would desire as relates to accurate closure and certainty that leakages will not occur.

With a Levine tube introduced into the stomach through the nose and feeding through this tube maintained for seven days postoperatively, in most of the cases there will be first intention healing, but because of the inaccuracy of the suture the large apertures into the true esophagus when the sac is large in third stage cases, there will be occasional cases in this group in which leakages occur. Having been done, as these cases have, in two stages, there will be no danger of mediastinitis or fascial plane cellulitis, but there will be in those rare cases of leakage the undesirable complication of food and fluid discharge through the wound until granulation and closure have occurred. It is for this reason that I wish to strongly urge that patients with esophageal diverticula be persuaded if possible to have their diverticula operated upon in the second stage and before they have reached the development of the third stage.

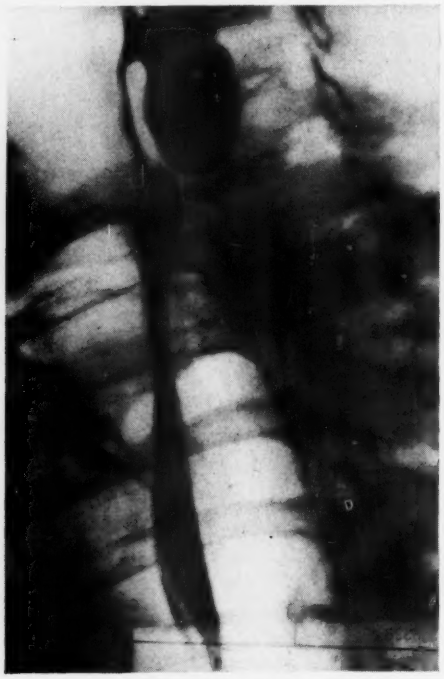

FIG. 9.—This is a true esophageal diverticulum, the lateral view showing the spill-over, the neck and that the true longitudinal esophagus is at the top of the sac where the thin stream of barium appears, and not at the bottom as occurs with simple dilatation.

ANESTHESIA

In the beginning of our experience, because we were never quite sure about the diverticulum and wished to have the patient able to swallow so that we could locate the diverticulum as it ascended and descended, these operations were done with procaine cervical block. This has for some time now been entirely abandoned in favor of general anesthesia, largely with ethylene and with an intratracheal tube. This is much more satisfactory to the patient and to the surgeon. As a result of our increasing experience with these cases we have no difficulty in finding the sac, and local anesthesia in the form of cervical block is a trying ordeal to the patient, only partly effectual in some cases and far from satisfactory even in expert hands in others. In addition to that, the position in which these patients must be, with their chins turned to one side, with their neck extended and their chest thrown forward, is an extremely uncomfortable one for the patient under local anesthesia to endure

during the period when this painstaking, accurate and in certain cases time-consuming procedure is carried out.

OPERATIVE PROCEDURE

The incision in esophageal diverticulum is of the utmost importance. I have never been in favor of doing this operation, which can be technically difficult in a field filled with complicated anatomy, with any limitation as to the adequateness of the exposure. For that reason I have never been interested in incisions of the goiter type made because of their superior appearance, as compared with the longitudinal incisions. We have always employed long

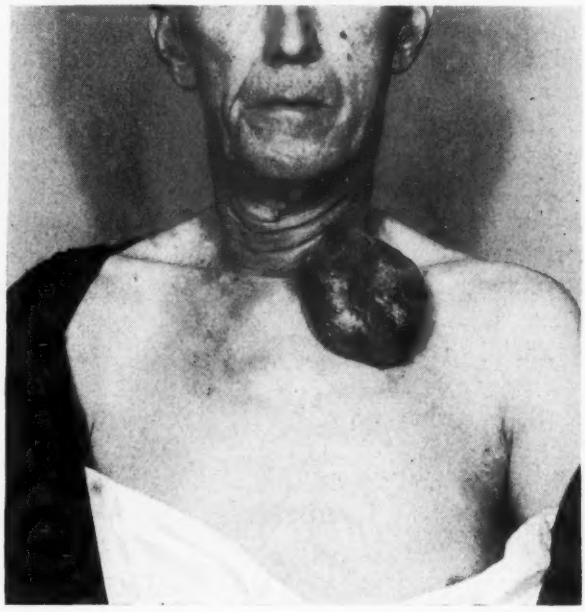

FIG. 10.—This illustrates how in an esophageal diverticulum with a very large sac it is necessary to implant the sac on the neck. One can realize in a sac that has reached this proportion how large the opening into the true esophagus will be and how undesirable it would be to attempt to ligate such a mass of esophageal tissue.

longitudinal incisions parallel to the anterior border of the left sternomastoid muscle. This provides what is so important in this condition, adequate exposure, good visualization of the anatomy, accurate control of bleeding so that the field can be kept dry, and anatomic relations at all times established. The need for these requirements, in my opinion, and the hazards of this procedure, particularly in difficult cases, by far exceed the importance of the appearance of the scar.

These incisions need to be carried high, up to and above the level of the point where the superior thyroid artery passes as the first branch of the external carotid to the upper pole of the thyroid gland, and low to the point

where the sternomastoid is inserted into the sternum in order that the inferior thyroid artery beneath which the sac always passes, may be visualized and in order that the lower portions of the deep sac in the third stage of this condition may be clearly visualized.

Operative Steps.—The first step of the procedure for the removal of esophageal diverticulum after the longitudinal incision has been made and the platysma cut, is the separation of the anterior edge of the sternomastoid muscle throughout the entire extent of the incision from the underlying prethyroid muscles. If this is done and the sternomastoid is pulled back, the anterior belly of the omohyoid muscle immediately comes into view. This is followed up to its point of insertion, a clamp is applied at its tendinous portion and the higher portion of the anterior belly of this muscle is freed, ligated at its insertion and at the tendinous portion, and removed. This immediately makes visible the internal jugular vein, the outer border of the sternohyoid muscle and the underlying thyroid gland with the superior thyroid artery passing into the upper pole, and the upper, middle and inferior thyroid veins passing from the thyroid gland to the internal jugular vein. These thyroid veins are doubly ligated and severed in order that a double blunt retractor may be placed under the outer edge of the thyroid gland and that structure so elevated that the inferior thyroid artery, beneath which the sac of the diverticulum passes, comes plainly into view. With the common carotid artery and the internal jugular vein retracted outward, the gland retracted inward (Fig. 11 *a*), the inferior thyroid artery comes into view. This is doubly ligated between clamps and beneath it will be found the sac of the diverticulum even in those cases with the smallest type of sac (Fig. 11 *b*). In large sacs this will make possible the dissection of the sac and the delivery of the sac out of the mediastinum. Without severing the inferior thyroid artery, this approach and dissection is impossible.

As soon as the diverticulum sac is identified it is grasped with Babcock forceps at its tip and the separation of the inner wall of the sac from the longitudinal esophagus immediately undertaken. In large sacs extending into the mediastinum the sac is gradually lifted out of the esophagus, placing Babcock forceps on the delivered portion progressively as it is pulled out of the mediastinum.

It is frequently possible to introduce one's finger along the outer edge of the sac and gently elevate the sac out of the mediastinum if it is not adherent. It can then be pulled away from the longitudinal esophagus so that the dissection between the inner wall of the sac and the lateral wall of the true esophagus can be carried accurately up to the neck of the sac (Fig. 11 *b*).

It is to be recalled that in all of these sacs there is a varying degree of investment of the sac by the fibers of the longitudinal esophageal muscle, spreading over it as a thin web of muscular tissue. It is of the utmost importance that the sac of the diverticulum be so dissected from its dependent position and that the acute angle made at its neck by the inner wall of the sac and the left wall of the true esophagus is completely freed (Fig. 11 *b*).

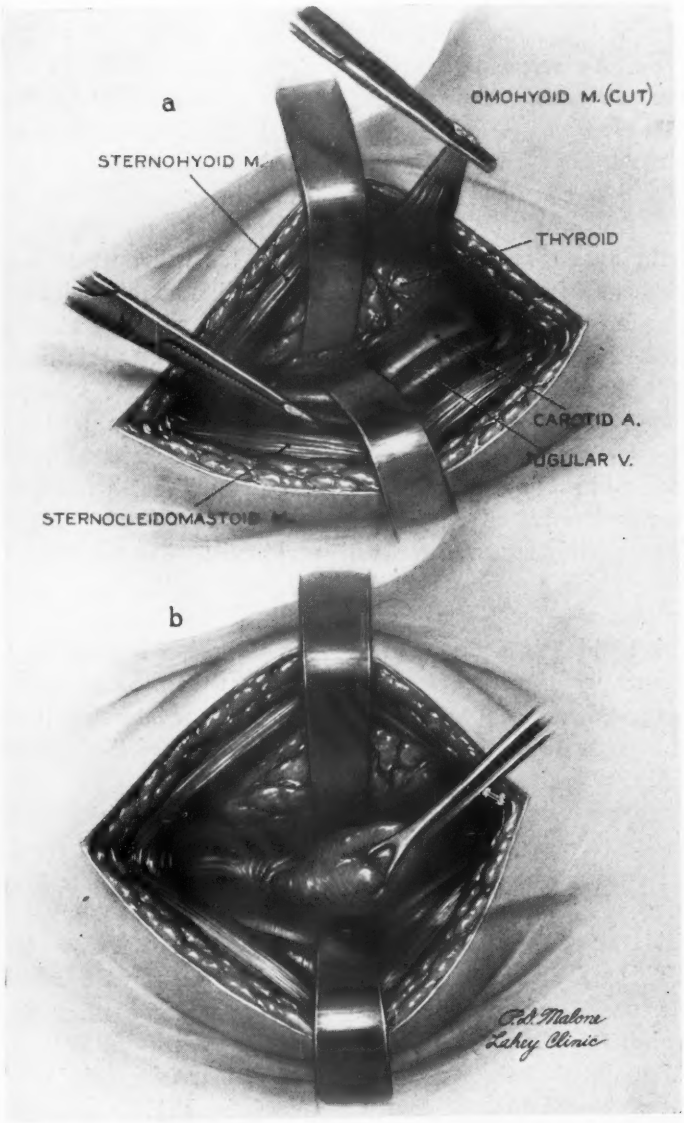

FIG. 11.—*a*, Note in this illustration that the omohyoid has been severed at its tendinous portion and the point of insertion is not shown in this illustration as clamped. The anterior belly is, however, to be removed. Note the retractor pulling the thyroid inward and the retractor ready to pull the common carotid and the internal jugular outward.

b, Note in this illustration the inward retraction toward the midline and the outward retraction of the large vessels. The diverticulum sac is completely dissected from its attachment to the longitudinal esophagus and pulled upward. Note the remaining circular fibers of the cricopharyngei or inferior constrictor about the lower angle of the sac neck. These are to be severed.

As shown in Figure 11 *a*, in order to be sure that one has completely accomplished the dissection of the neck of the sac, this dissection must be carried completely around the neck of the sac until the pale white membrane of the submucosa is shown. It is only when this structure can be demonstrated around the entire neck of the sac that one can be sure that all of the muscle fibers enveloping the sac have been removed and that the acute angle at the neck of the sac has been completely dissected (Fig. 12 *a*).

There will be a tendency of everyone who has not had considerable experience with this dissection to stop short of complete dissection of the lower angle of the neck of the diverticulum sac. This will be true because there will be a constant fear that too extensive dissection at this point can result in perforation into the sac at its neck. It is for this reason that I have always employed the Berens-Beebe loupe to magnify the field at this time and make certain that the dissection here is not carried beyond the safe point of the wrong side of the pale white submucosa and a perforation produced.

If the angle, as shown in Figure 12 *b*, is not completely freed, one can see that this will produce a shelf or ledge which will catch food, throw it out into the incomplete sac which will remain after suture or ligature of the necessarily incompletely removed sac, which will exist when this mistake is made. As a result of this pressure, there will be present all of the factors for the formation of a new sac.

There is nothing in my opinion which is of greater importance in preventing the recurrence of an esophageal diverticulum than the complete dissection of the lower angle of the neck of the sac made by one lateral wall of the longitudinal esophagus and the corresponding lateral wall of the sac of the diverticulum (Fig. 12 *a* and *b*).

Since esophageal diverticulum actually arises posteriorly from the midline of the esophagus, it is obvious that the dissection of the sac on the left side will not be difficult because it can be so satisfactorily visualized, but the dissection of the envelopment of the sac by the longitudinal muscle fibers on the right side, and the delivery of the sac to the left will at times be extremely difficult. This will be due to the fact that the investment of the sac on the right side cannot be visualized. It will be necessary by rotating the sac laterally to the left to gradually remove the investing fibers on the right side, and it is at this point that there is the greatest danger of unwittingly making a hole in the neck of the sac on the right side (Fig. 13).

So great is the danger of perforating the sac in freeing it from its muscular investment on the blind right side that it is my opinion that if there is any difficulty whatever in doing it or any uncertainty about the safety of doing it, the sac should be delivered as far as possible and the freeing of the right side of its neck from musculature investment delayed until the second stage when it can be done with just as great ease and with the added safety of the fascia planes and mediastinum being so sealed-off should a perforation be made in the neck at this point that it will not result in a mediastinitis and possible fatality.

With the sac completely dissected, if it is large, it is implanted in the

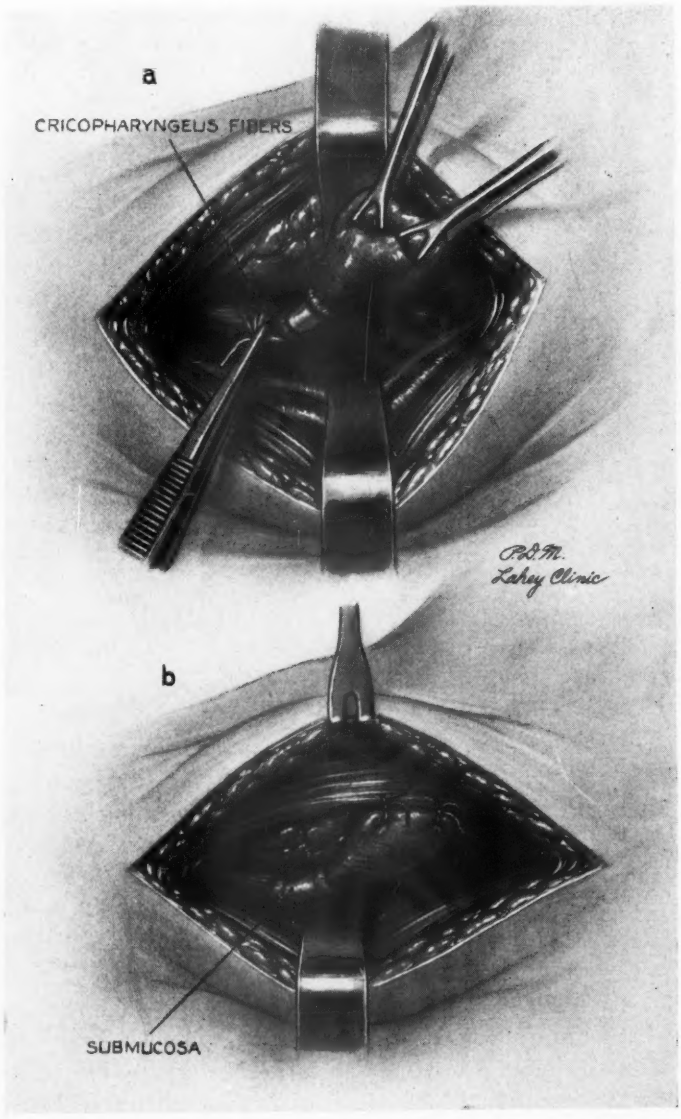

FIG. 12.—*a*, Note in this sac the complete dissection of the neck, with the pale white surface of the submucosa. Note the removal of the sling fibers about the neck of the sac at the angle. The sac has been completely dissected from its attachment to the longitudinal esophagus so that it actually hangs by its neck.

b, Note again the completely dissected neck with its pale white submucosa and that the sac has now been approximated to the prethyroid muscle.

This illustration gives the impression that the stitches have passed through the sac. They have been passed through only the adventitia about the sac but care is taken to see that the needle does not penetrate the sac. This makes it possible to bury the small sac within the wound and to find it easily at the second stage of the operation.

wound and on the neck for seven or eight days (Fig. 10). If it is small, the tip of the sac is sutured high up to the very outer edge of the sternohyoid muscle, care being taken to tie the silk suture about some of the adventitious tissue over the sac and not to put a needle through the wall of the sac (Fig. 12 *b*). If a needle is put through the wall of the sac to sew it to the prethyroid muscle, this will result in its pulling away with swallowing, in leakage, and will result in undesirable contamination and infection of the wound.

As shown in previous descriptions of this procedure, two black silk stitches (Fig. 12 *b*) are used to suture the sac to the uppermost edge of the sternohyoid muscles, leaving the ends long, by means of which the point of fixation of the sac can be readily demonstrated at the second stage of operation.

FIG. 13.—This diagrammatic illustration is included without the surrounding anatomy to demonstrate how the musculature enveloping the sac on the right side must be freed in order that the submucosa completely around the neck of the sac can be demonstrated.

Since this dissection of the right side must be made through a left incision, the difficulty of exposing this region is obvious.

If the mediastinum has been widely opened, a good sized pack is introduced into it and carried up along the edge of the longitudinal esophagus to the level of the neck of the diverticulum. This pack is left in place for four days at the end of which time it is removed entirely. The second stage of the operation is carried out seven to eight days later.

It is readily possible with a large diverticulum sac to pull it so far out upon the wound that there will be such angulation of the esophagus that the patient will not be able to swallow between the first and second stages. Before implanting a large sac in the wound and on the skin one must be careful to see that the longitudinal esophagus is in the midline and not disturbed and distorted in its course.

Second Stage.—The second stage of this operative procedure can be undertaken at any time in from seven to twelve days after the first stage. We have done these second-stage procedures at various intervals of time, and it is my opinion that the operation will be most satisfactory when it is done on approximately the seventh, eighth or ninth day after the first stage.

If one does not undertake the second-stage operation until a later day than this, the wound will be firmly united, quite difficult to separate and the difficulty of establishing cleavage planes will be greater than if the operation is undertaken on the eighth day.

Even though the drain has been removed on the fourth day, if the second stage of the operation is undertaken on the eighth day there will still be a drainage canal along which a finger can be inserted as the wound is opened.

This is a desirable line of cleavage to establish as it permits separation of the granulation-covered internal jugular vein and common carotid artery from the prethyroid muscles, thyroid and esophagus so that they can be separated in opposite directions and the region of the esophagus exposed.

At this point the black silk sutures anchoring the sac to the prethyroid muscle are found indicating the location of the implanted tip of the sac. The sac can readily be picked up with tacking forceps, severed from the point where it is sutured to the prethyroid muscles and its neck easily wiped out with gauze. When the neck has been well freed at the first operation, its relation

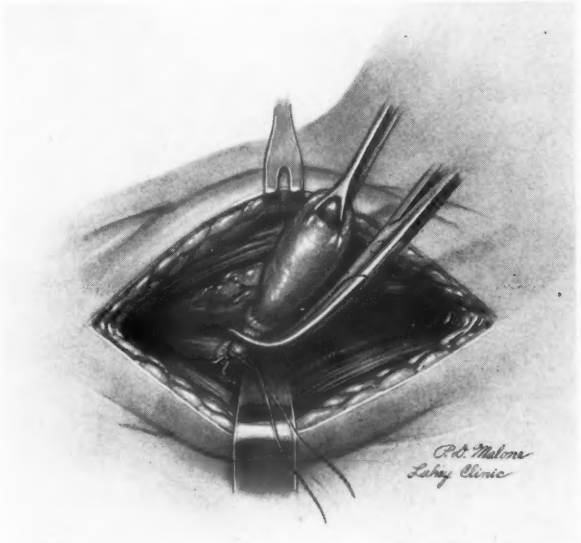

FIG. 14.—This illustration represents the method of ligating the sac at the second-stage procedure when all the fascial planes have been walled-off. One ligature is shown about the sac already tied, the second ligature is about the sac but not yet tied. Note the clamp applied distally to avoid spilling of the infected contents of the sac. Note again that the pale white submucosa, demonstrating how completely the neck of the sac has been dissected, is shown.

to the true esophagus can easily be established at the second operation, and in those patients with a small sac and a narrow neck, an accurate ligature of 0 chromic catgut can be passed around the neck flush with the esophagus. The neck is doubly ligated, the neck of the sac distal to the ligature clamped and the neck itself severed (Fig. 14). A small amount of sodium sulfathiazole is placed over the ligated neck of the sac, a cigarette drain laid over this, and the wound reclosed.

In the large sacs implanted in the wound, the neck can be readily reopened along the neck of the sac as it emerges onto the skin where it is placed.

At the second stage of the operation it is wise and of no disadvantage to reopen the wound completely throughout its full extent since it heals readily

when reclosed. This gives adequate exposure of the anatomic structures, permits free mobilization of the sac and makes much easier the ligature or suture of the neck of the sac. Suture of the neck of the sac at best is difficult since it must be done behind the esophagus and where the esophagus joins the pharynx.

As already stated, in small sacs, a double ligature of the neck of the sac and cutting away the sac is an extremely satisfactory way of handling them, but in either large or small sacs one should first introduce a Levine tube

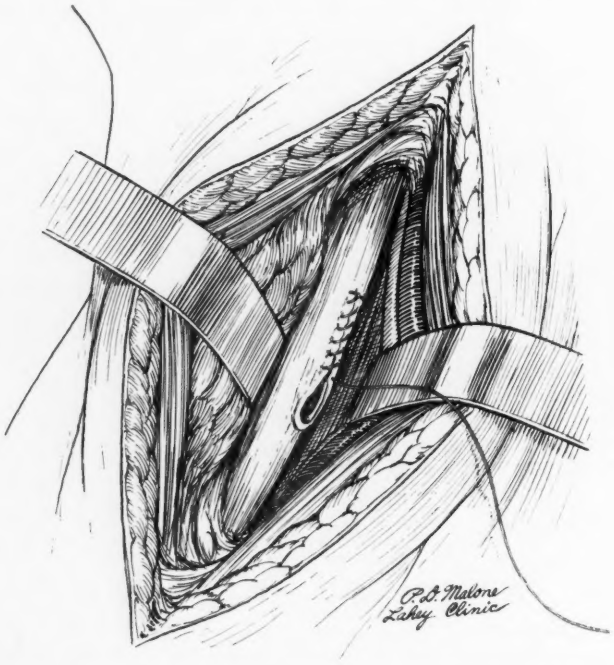

FIG. 15.—This illustration shows the method of suturing the opening into the esophagus in large diverticula with large openings into the esophagus. These openings are so large that ligature of such a large mass of tissue is less satisfactory than is suture. I would like to say for the benefit of anyone doing this suture that such are the difficulties of doing it that it is often a far from accurate suture line but, with an indwelling tube, rarely leaks.

through the nose into the stomach at the time of the second-stage operation. If there is any difficulty in passing it into the esophagus, this can be delayed until the neck of the sac is exposed at the second stage, at which time the operator can, as the anesthetist passes the tube down into the pharynx, guide the tip of the tube into the longitudinal esophagus. This is important since with either suture or ligature of the neck of the sac, all feedings should be maintained for seven days through the indwelling nasal Levine tube in order to give the closed esophagus an opportunity to heal by first intention.

I wish to warn particularly of the difficulty of suturing the neck of the sac in diverticula with large sacs when the opening into the true esophagus is

frequently of considerable size. Since the right side of the neck of the diverticulum sac cannot be visualized, one must be careful lest in his enthusiasm to get rid of the entire sac that part of the right lateral wall of the esophagus is not so pulled over and sutured to the left side that there is narrowing of the esophagus. I have personally done this in one case, necessitating reoperation and a plastic upon the narrowed esophagus. Again, a drain is inserted into the mediastinum and along the edge of the esophagus, which remains for four days, at the end of which time it is completely removed.

COMPARISON OF THE TWO-STAGE WITH THE ONE-STAGE PROCEDURE

There have been but two deaths in this group of 209 cases, all of which have been done by the two-stage method. One was due to an error in judgment in operating on a man 84 years of age who had had complete obstruction for some time and who died of uremia four days after the first-stage operation and with no difficulty relating to the operation upon the diverticulum.

The second fatality was a technical error in a patient upon whom I made an opening on the blind right side of the sac without being aware of it until three or four days after operation when food and saliva escaped from the wound. This was a technical error, and this patient died of mediastinitis in spite of gastrostomy and posterior mediastinotomy.

The decision to remove a pulsion diverticulum by one or two stages must be largely a matter of personal choice; the mortality of reported series done by both methods is approximately the same. The period of stay in the hospital, now that we have been successful in a series of over 60 cases in successfully closing the opening into the longitudinal esophagus at the second stage and obtaining first intention healing without leakage, is about the same, approximately two weeks. The incidence of recurrence by both methods will be about the same since it depends largely upon how well and how completely the sac has been dissected and because by either method their exist no muscular structures of any real value which can be sutured over the ligated or sutured sac neck to reinforce it.

My own adherence to the two-stage plan of operation is due to the fact that the only two deaths which have occurred in 209 cases have been my fault and not the fault of the operation and because at the second stage of the two-stage operation, when the mediastinum and the fascial planes of the neck are sealed off, should there be leakage, as will occasionally occur with either the one-stage or the two-stage procedure, I do not have to worry about either mediastinitis or fascial plane infection in the neck. This is particularly true when the closure of the remaining opening into the esophagus can be just as satisfactorily done at the second step of the second-stage procedure as it can at the time of exposure and ligature or suture in the one-stage operation.

With no purpose of disparagement of the one-stage operation, with no attempt to persuade those who employ it away from its use, with perhaps an unnecessary sense of caution concerning the possibility of the occurrence of mediastinitis when leakage with the one-stage operation occasionally occurs,

as it does, but with a gratifying certainty that when leakage does occur after the second-stage procedure of the two-stage operation, as it occasionally does, mediastinitis will not occur, I would, I believe, should I ever have to have this operation done on me, accept the relatively simple second-stage procedure. I would consider it a small price to pay for the peace of mind which goes with it regarding absence of leakage dangers, for other than this and perhaps the three to four extra days in the hospital, there is nothing different in the effectiveness of either plan of operation.

DIVERTICULA OF THE LOWER THORACIC ESOPHAGUS*

REPORT OF SIX, FOUR OF WHICH WERE OPERATED UPON

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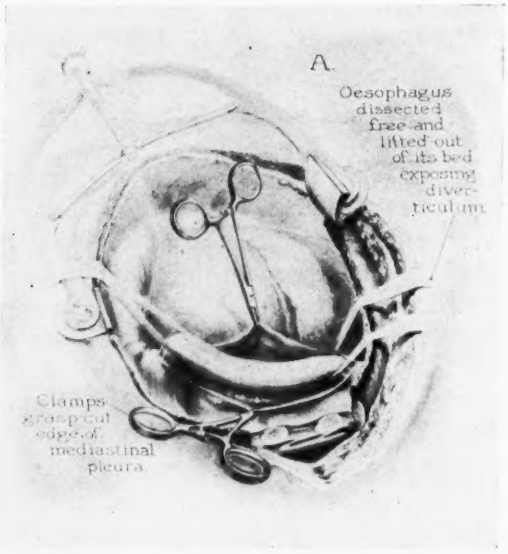
THE AVAILABLE LITERATURE would suggest that diverticula of any portion of the thoracic esophagus are uncommon. In 1928, Smith[2] was able to collect from the literature, between 1919 and 1926, inclusive, four diverticula of the upper third, six of the middle third and 16 of the lower third. He reported nine cases, six single and three multiple, only two of which were limited to the lower third, and stated that Dessacker found reports of 21 diverticula of the epiphrenic variety which, with his own and those of Carman and Hurst, made a total of 26. Vinson[3] collected 42 cases of diverticula of various portions of the thoracic esophagus from the records of the Mayo Clinic up to 1934. Only 18 of these patients were thought to have symptoms which could be related definitely to the diverticula and in none of these was the disability considered great enough to warrant operation. Barrett,[1] in 1934, was able to collect from the literature a total of 115 cases and to report one of his own which he operated upon, with a satisfactory result.

While it is probably true that these reports do not really represent the frequency of the disease and that with improvements in roentgenologic methods of examination of the esophagus the condition is likely to be recognized more frequently, reports of what may be called giant diverticula remain of interest.

Diverticula of the thoracic esophagus are described as of the traction or pulsion variety. The former are characteristically of a more or less conical shape and result from fixation of a point on the outer wall of the esophagus to an adjacent inflammatory area most often a tuberculous lymph node. Because they have wide-open mouths food is unlikely to stick in them and they do not produce symptoms except in the rare instances in which perforation occurs. The pulsion form is said to result from herniation of the mucous membrane through the muscular wall and to be enclosed, therefore, by mucosa, submucosa and fibrous tissue only. The diverticula removed in this series had rather thick walls formed of squamous epithelium, submucosa, muscularis mucosa and a layer of fibrous tissue. The muscle in Case 1 was of considerable thickness but apparently represented muscularis mucosa only. The muscle in the other cases was patchy in distribution and rather scanty. In all, there was a fairly marked infiltration of inflammatory cells in the submucosal area. Their etiology is obscure. Some appear to be associated

* Read before the American Surgical Association, April 2–4, 1946, Hot Springs, Virginia.

FIG. 1



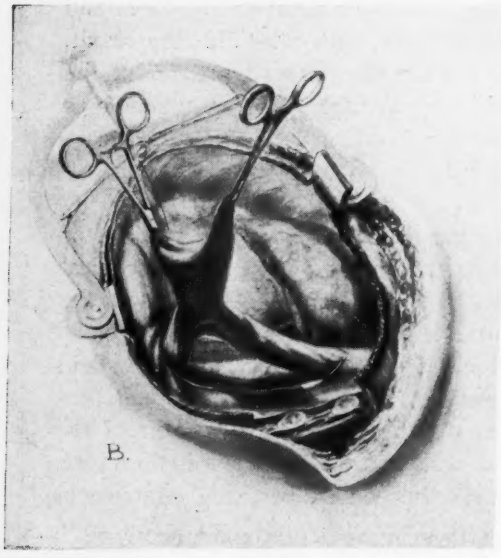


FIG. 2

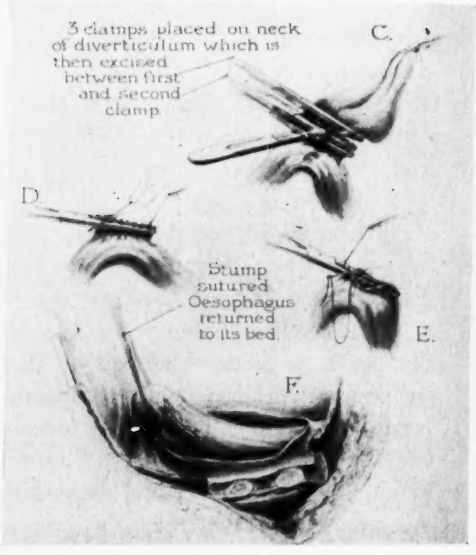


FIG. 3

FIGS. 1, 2 and 3.—Operative technic. (1) Shows the exposure obtained; (2) the diverticulum freed and held up by clamps; (3) the method of excision and suture.

with cardiospasm and have been regarded as a complication of that condition. Since diverticula are found so rarely in cases of cardiospasm some additional factor must be present in those cases that develop them. It has been suggested that they arise in areas of congenital weakness of the esophageal wall. While it does not exclude a congenital origin the fact that symptoms in this series of cases, all of which were of the pulsion variety, began at 41, 42, 51, 52, 54 and 59 years of age, suggests a degenerative rather than a developmental cause.

To the two main varieties Barrett has added a third—the traction-pulsion diverticula, in which a combination of the etiologic factors is said to exist.

Symptomatology: Difficulty in swallowing is the outstanding symptom. It may be noted first in taking liquids or may be most troublesome with solids. Pain is nearly always present beneath the lower sternum or xiphoid and, in addition, may be referred to the interscapular region. Vomiting occurred in half of this series and another had regurgitation. Loss of appetite follows, and the patient begins to lose weight. Weight loss and dehydration, as in Case 2, may be extreme. For the most part the symptoms seem to occur in episodes at gradually lessening intervals. The patient may be entirely free from discomfort for long periods.

FIG. 4.—Case 2: Preoperative film.

Diagnosis: Diagnosis is based upon the clinical history and the barium examination of the esophagus. It was possible in two cases to suspect the condition from the plain roentgenogram, and it is probable that familiarity with the appearance shown in Fig. 11 might result in the condition being recognized by the radiologist when not suspected by the clinician.

Treatment: Diverticula discovered accidentally in the course of routine barium meals need no treatment. Those associated with symptoms should be operated upon. Difficulty in swallowing seems to have arisen in some, as in the pharyngo-esophageal variety, by the opening into the pouch becoming the more direct continuation of the lumen of the esophagus and the distended diverticulum pressing upon and distorting the esophagus below the opening. Since the symptoms are often present in episodes only, and may disappear completely for long periods following a short regimen of physical rest and bland diet, they are probably initiated at times by an inflammatory swelling. Despite the knowledge that any one attack may be recovered

from, operation should be advised in large diverticula while the patient is still in good general condition. The danger of ulceration and perforation or hemorrhage has to be considered. When operation has been deferred too long and the patient has become seriously ill through malnutrition and dehydration or suffers in addition from other serious conditions, as was the case in three of these patients, the danger is much increased.

Operative Procedure: When present, malnutrition and dehydration should be corrected as completely as possible. This is accomplished most readily by continuous feeding through a duodenal tube. The esophagus and diverticulum should be washed out with a tube on several occasions for 24 hours before operation in order to remove from them all food particles and mucous

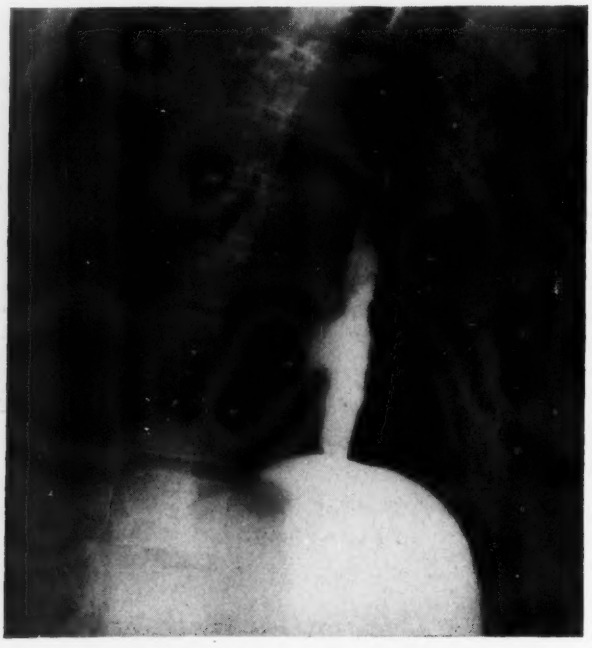


FIG. 5.—Case 2: Two months after operation. The removal could have been more complete.

secretions. A duodenal tube in the stomach at the time of operation aids in identification of the esophagus. It should remain in position postoperatively to permit aspiration of fluid and air from the stomach for the first day or two and feeding during the next few days. Swallowing may be permitted on about the fifth day. Intratracheal closed anesthesia should be employed. This is important because if the surrounding tissues are very adherent to the sac the right pleura is easily opened. A posterolateral approach through the seventh or eighth intercostal space has been found satisfactory. As in all operations of similar magnitude, blood should be replaced as lost. The chest should be closed with an intercostal water-seal drain. The systemic use of penicillin for five to seven days postoperatively lessens the danger of

local infection and of pulmonary complications. The details of the operative technic are described in the case reports and illustrated in Figures 1, 2 and 3.

CASE REPORTS

CASE 1.—Dr. Chas. C., age 60. Admitted July 9, 1934; discharged September 4, 1934.

The patient, a 60-year-old physician, first noticed difficulty in swallowing one year previously. The food seemed to stop in his chest and there was a sense of pressure substernally. Swallowing more food would then give him great discomfort. Later, he had attacks of vomiting which were preceded by nausea and were very severe but lasted only a short time. The material vomited tasted bitter. It never contained blood. He had had pain in the chest for one year. This was at times substernal and at times between the shoulders and seemed to "bore" into the spine. For the last three

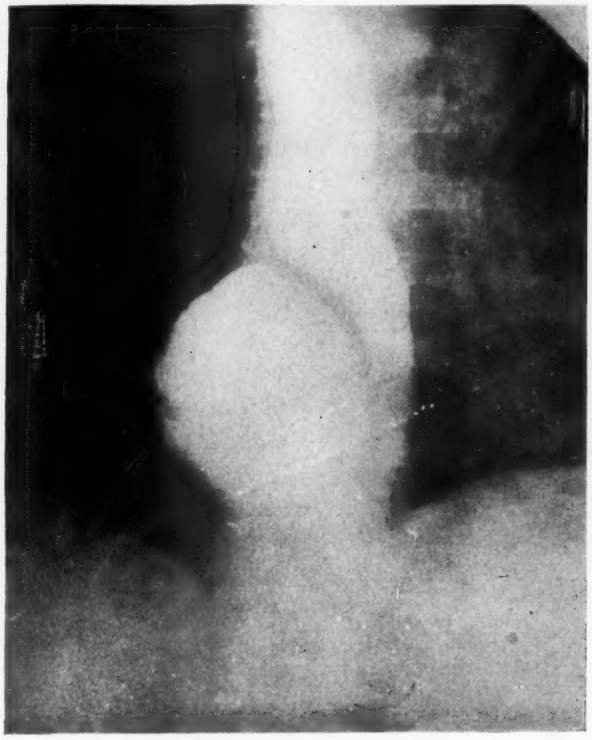


FIG. 6.—Case 3: Preoperative film.

months it had been constant. His appetite was good. He had lost 20 lbs. during the three months before admission. He was a chronic alcoholic and had for some time been taking three grains of morphine daily.

Examination revealed a man who looked much older than his years, and who had obviously lost a good deal of weight. The blood pressure was 120/80. The arteries were moderately thickened. The chest was barrel-shaped and there were a few râles at both bases. The abdomen was protuberant but otherwise normal. Barium examination of the esophagus disclosed a saccular diverticulum three cm. in diameter about two inches above the diaphragm.

Operation—July 23, 1934: Under intratracheal ether anesthesia, the left chest was opened through the seventh interspace. The mediastinal pleura was incised for three inches in the region of the diverticulum and the esophagus and diverticulum were gently isolated and lifted forward on tapes. The sac arose from the posterior aspect of the esophagus and passed to the right. It was the size of an English walnut, thick-walled, and seemed in a state of contraction. It joined the esophagus by a neck two cm. in diameter. A stomach tube was passed. Three Kocher forceps were placed across the neck of the diverticulum, which was then divided with a cautery between the two distal clamps. The second clamp was removed and the fringe of tissue left oversewn with a running suture of chromic catgut on an atraumatic needle. The third clamp was removed and the first layer of sutures invaginated with a second of a Lembert type. There was no encroachment on the lumen. The divided mediastinal pleura was sutured behind the isolated portion of the esophagus in order that infection, if it should occur, would involve the pleural cavity and not the mediastinum. The chest was closed leaving a water-sealed intercostal drain to the site of operation.

FIG. 7.—Case 3: Five weeks postoperative. Difficulty in swallowing due to cardiospasm.

Pathologic Report: The specimen consisted of a thick-walled sac three and one-half cm. in depth and three cm. across at the point of division. Microscopically (Fig. 4), the wall was composed of a layer of fibrous tissue, a rather thick layer of smooth muscle and a lining of squamous epithelium in which at one place was an old, partially healed ulcer. There were many chronic inflammatory cells in the submucosal zone.

Postoperative Progress: Convalescence was rather stormy, and for a short period of about ten days there was an esophageal fistula along the site of the drainage tube. There was a small effusion, but no infection of the general pleural cavity occurred. Management was rendered difficult by the morphine addiction. Barium examination, September 5, 1934, showed an apparently normal esophagus, it being impossible to recognize any definite defect at the former site of the diverticulum. The patient was eventually cured of the morphine addiction and survived nine years without symptoms referable to the esophagus.

CASE 2.—James C., male, age 58. Admitted June 26, 1944; discharged August 29, 1944.

In 1923, he had a gastro-enterostomy performed for duodenal ulcer. After five or six years of complete comfort he began to have episodes of pain beneath the xiphoid following the taking of food. These attacks became more severe as time passed and during the last year had been much more frequent and much worse. For the past month he had been in continuous trouble. The pain came on immediately following food and he often had to leave the table to vomit. The vomitus tasted bitter. He had lost an estimated 25 lbs. in weight and had become pale and weak. The diverticulum had been recognized in roentgenograms taken in 1942.

On examination, the patient was very thin, very pale and dehydrated. The abdomen was scaphoid and there was a scar of a well-healed upper right rectus incision. Examination of the anterior chest was negative but posteriorly there was a distinct area of dullness to the right of the seventh and eighth dorsal vertebrae. Percussion

FIG. 8-A FIG. 8-B

FIG. 8.—A and B.—Case 3: March, 1946. Some dilatation of esohpagus remains together with a bulge where diverticulum removed. No interference with function.

over this area was painful and elicited from the patient "that's it." There was a slight but definite generalized enlargement of the superficial lymph nodes. A diagnosis of chronic lymphatic leukemia was made by a consulting physician. The roentgenograms (Fig. 4) showed a diverticulum about three inches in diameter arising apparently from the posterior aspect of the esophagus about two inches above the diaphragm and pointing to the right.

Despite the diagnosis of lymphatic leukemia and the fact that because of this and the state of malnutrition he was a poor operative risk, it seemed that operation should be undertaken. A duodenal tube was passed into the stomach without difficulty and he was fed a high protein mixture by continuous drip for a little more than a week. During this period his weight increased 11 lbs., and he felt and looked much better.

Operation—July 7, 1944: Under intratracheal ether anesthesia, the left chest was opened through the seventh interspace, using a posterolateral approach. The mediasti-

nal pleura was incised along the posterior margin of the lateral ligament of the lung. The esophagus was exposed just above the diaphragm and a tape placed about it, and a similar procedure was carried out just below the root of the lung. By lifting on these tapes it was possible to bring the intervening portion of the esophagus forward and to the left and begin the dissection of the diverticulum. It was moderately adherent to the surrounding structures including the right pleura and the right vagus nerve, the latter being removed on its surface. When freed, the sac was seen to arise from the posterior aspect of the esophagus about three inches from the diaphragm. It was removed and the cut-surface oversewn, as in Case 1. In addition, a covering of adjacent areolar tissues was provided. The divided pleura was again closed behind

FIG. 9.—Case 4: Preoperative film.

the isolated portion of esophagus. The chest was closed leaving a water-sealed intercostal drain through a stab wound in the ninth interspace in the posterior axillary line. The operation was well-tolerated.

Pathologic Report: The specimen consisted of a sac-like structure 7 x 4.5 cm. The wall measured approximately two mm. in thickness. Microscopically, it was formed of squamous epithelium, submucosa, muscularis mucosa and a thick layer of fibrous tissue. Many chronic inflammatory cells were seen in the submucosal area. The muscle fibers were separated into bundles and did not form a continuous layer.

Postoperative Progress: The duodenal tube was left in place and feedings con-

tinued through it until it was removed on the 13th day. Tube feeding was continued longer than usual because of the poor state of nutrition. The intercostal drain was removed on the third postoperative day. There was a great deal of trouble in clearing bronchial secretions and some pulmonary atelectasis and infection. A rather late, and not very active, streptococcus infection of the chest wound occurred which required drainage, but cleared fairly rapidly when it was possible to obtain penicillin for systemic use. He swallowed well after removal of the tube. Recovery was slow.

Barium examination of the esophagus, August 29, 1944, showed that the opaque material passed into the stomach readily and without obstruction to its flow. At the site of the former diverticulum was a small pocket, indicating that removal had not been quite complete (Fig. 5).

This man was a very poor operative risk because of starvation and the associated leukemia. He was relieved of esophageal symptoms and remained comfortable and

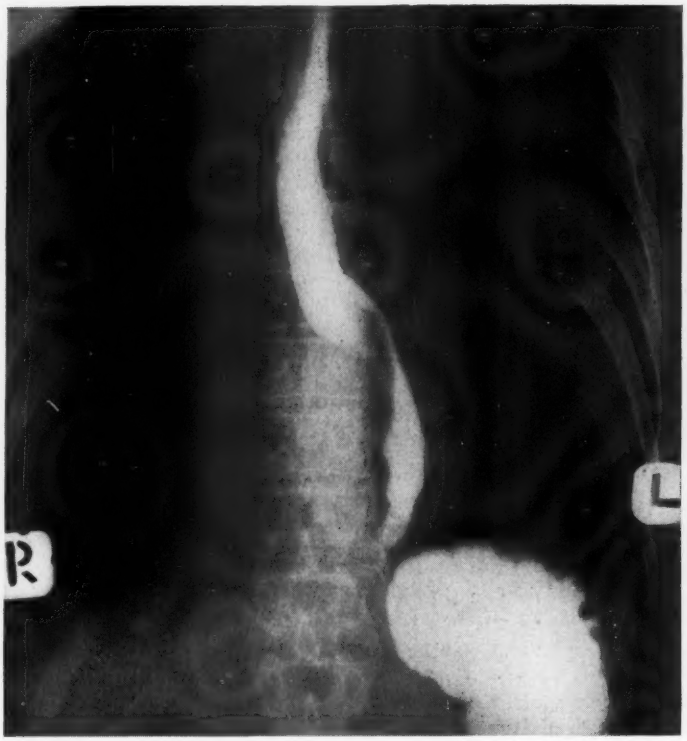


FIG. 10.—Case 4: March 1, 1946. Esophagus normal apart from displacement into chest.

relatively well until admitted to the local hospital, May 5, 1945, with severe epistaxis from which, in spite of transfusions, he died.

CASE 3.—Henry G., male, age 55. Admitted January 8, 1945; discharged March 2, 1945.

One year before admission he began to notice difficulty in swallowing water and that when he lay down, particularly upon the left side, the water regurgitated into his mouth. Solid foods then began to stick and to be returned sour. During the attacks there was discomfort beneath the lower end of the sternum. He had been admitted to the medical wards in August, 1944, at which time a diagnosis of moderately advanced bilateral tuberculosis, nonbacillary, had been made. The plain roentgenograms

of the chest had shown a fluid level to the right of the spine, and a subsequent barium examination had disclosed a diverticulum of the lower portion of the esophagus. Since treatment of the tuberculosis seemed the more urgent matter he was transferred to a sanatorium. The tuberculosis improved but the difficulty in taking food was thought by the sanatorium physicians to be interfering with his recovery. He was returned to the general hospital, therefore, for operation.

The patient was a strongly built, moderately well-nourished man. Clinical examination was negative so far as the esophagus was concerned. Medium and low-pitched râles and some rhonchi were heard over both sides of the chest in the apical and midlung fields. Roentgenograms of the esophagus showed a diverticulum more than three inches in diameter, which seemed to arise about two inches above the diaphragm and pass to the right (Fig. 6).

Operation—January 15, 1945. The operative procedure was essentially the same as carried out on Cases 1 and 2. Because the postoperative roentgenologic examina-

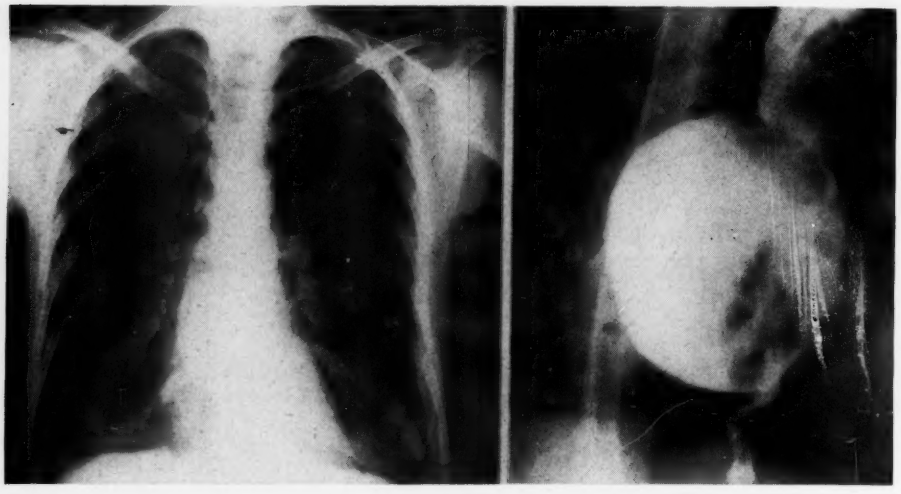


FIG. 11 FIG. 12

FIG. 11.—Case 5: Plain film showing diverticulum with fluid level to right of spine.
FIG. 12.—Case 5: Diverticulum filled with barium.

tion in Case 2 had suggested that removal of the diverticulum might have been somewhat more complete, the clamps were placed a little closer to the esophagus.

Pathologic Report: The specimen consisted of a moderately thick-walled sac measuring eight cm. in its greatest diameter. Microscopically (Fig. 5), the wall was formed of squamous epithelium, submucosa and a thick layer of fibrous tissue. There was a moderate number of chronic inflammatory cells in the submucosal zone. No muscle tissue was seen.

Postoperative Progress: Recovery from operation was uneventful, but some difficulty in swallowing and a feeling of substernal fullness remained. Barium swallow on February 8th showed narrowing of the lower end of the esophagus with interference with the passage of the mixture and dilatation of the esophagus proximal to this. A second barium swallow on February 19th (Fig. 7) showed that the obstruction was apparently at the cardia. On February 25th, the cardia was dilated with bougies. Following this the patient was able to swallow without difficulty and on March 1st a barium mixture passed without difficulty. There has been no recurrence of symptoms.

A recent roentgenogram (Fig. 8) showed considerable spasm of the esophageal wall and a bulge in the area from which the diverticulum had been removed but the patient swallows easily and has gained 25 lbs. in weight.

CASE 4.—G. S. W., male, age 57.

Symptoms of indigestion, in the form of pain in the xiphoid region, began in 1942. The distress usually appeared on first taking food but sometimes not until halfway through a meal. He had attacks which lasted from a few hours to a few days, never more than a week, and had periods as long as a month of complete comfort. There was marked loss of appetite and strength, and his weight had dropped from 167 to 147 lbs. There was no vomiting.

Clinical examination was negative insofar as the esophageal lesion was concerned. Roentgenograms showed a diverticulum (Fig. 9) of the lower esophagus, about two to three inches in size. It arose by a relatively narrow neck about three inches above the diaphragm.

Operation—April 26, 1945: The operative procedure was, again, essentially similar.

Pathologic Report: The specimen consisted of a rather thick-walled sac lined with grayish mucous membrane. Microscopically, there was an inner layer of squamous epithelium, a submucosal zone in which there were many chronic inflammatory cells and a thick outer coating of fibrous tissue. Patches of muscularis mucosa remained.

Postoperative Progress: Recovery was uneventful. The patient has been relieved of symptoms. A recent roentgenogram (Fig. 10) showed an apparently normal esophagus except that the portion behind which pleura was sutured is displaced to the left.

FIG. 13.—Case 6: Diverticulum when symptoms present.

CASE 5.—Bessie W., female, age 45.

This woman, a vagrant, first presented herself at an Out-patient Clinic, October 21, 1942, complaining of difficulty in swallowing which had begun three weeks previously, and from which she had almost recovered. It was described as an obstruction "which comes and goes." The Wassermann reaction was found to be strongly positive and she was referred for treatment. No special attention was given to the difficulty in swallowing. She reappeared in March, 1943, with the same complaint and, again, in April, 1943, requesting that she be placed on relief because of "stomach trouble." She stated that she now had attacks during which the food stuck in her chest and would not go into the stomach. The food was vomited, giving relief. On May 18, 1945, she returned to the clinic complaining that in addition to difficulty in swallowing she now had chronic cough and sputum. A roentgenogram of the chest was taken and, in reporting on this, the radiologist called attention to a fluid level in the lower chest to the right of the midline, and suggested an examination of the esophagus. She was finally admitted to the medical wards, July 12, 1945, in a state of acute alcoholism complicated by bronchopneumonia. The radiologist's report upon the films of the chest made at that time is interesting (Fig. 11): "Situated on the right side and overshadowed by the cardiac outline there is a smooth opacity having a convex lateral and inferior border and projecting from the shadow of the thoracic spine for a dis-

tance of two cm. It is ten cm. in vertical height, with a fluid level superiorly." Subsequent examination of the esophagus disclosed the very large diverticulum (Fig. 12) which again arose from the posterior surface and projected to the right. It was deemed unwise to operate upon this patient.

FIG. 14

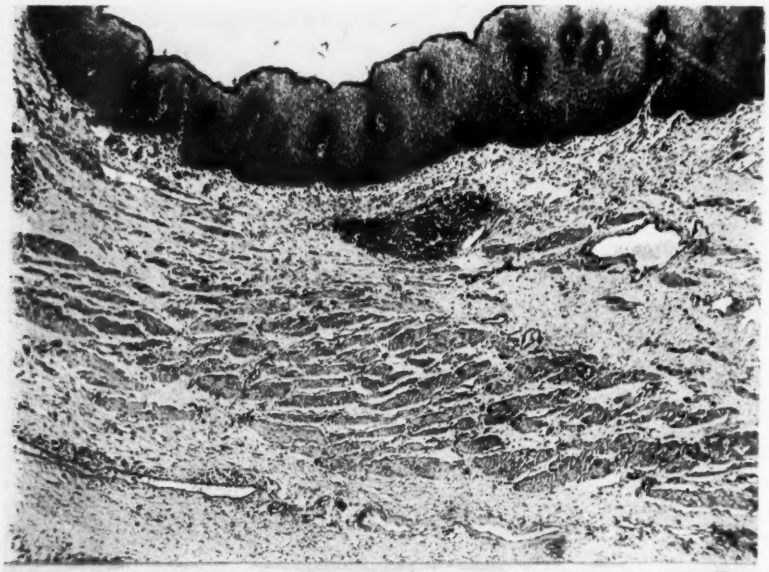


FIG. 15

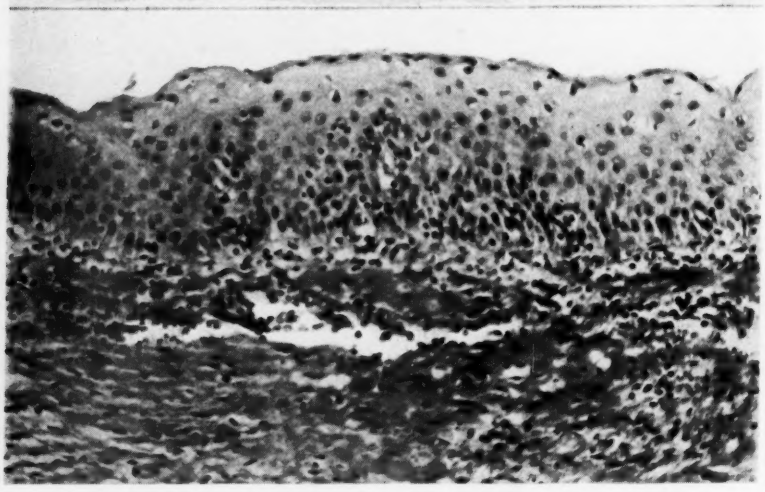


FIG. 14.—Case 1: Photomicrograph (x/55), showing well-developed muscularis mucosa.

FIG. 15.—Case 3: Photomicrograph (x/160), no muscle could be recognized.

CASE 6.—Joseph T., male, age 51. Admitted March 13, 1945; discharged March 16, 1945.

This man, a laborer, was in good health until four and one-half months before

admission, at which time he began to have a feeling of distention after meals and aching in the epigastrium. The latter had increased in severity and had been accompanied, latterly, by distress in the interscapular area. He had lost appetite, tired easily, and his weight had decreased by 15 to 20 lbs. There had been no vomiting.

Physical examination gave no clue to the nature of the disability. Barium examination of the esophagus disclosed a large diverticulum arising just below the lung root and projecting to the right (Fig. 13).

The patient left hospital with the expectation that he would return for operation, but after several weeks' rest the symptoms disappeared, his appetite returned and he regained the lost weight. When last heard from he was free from symptoms and working. It is probable that with a return of symptoms he will require operation.

SUMMARY

Six diverticula of the lower esophagus have been reported, four of which were operated upon. The condition is uncommon, but should be considered as a possible cause of difficulty in swallowing and substernal distress. Those responsible for symptoms and possibly all of what may be described as giant diverticula should be operated upon. In spite of the fact that only one of the four cases operated upon could be considered a good operative risk, no patient died as a result of operation. The routine postoperative use of penicillin should decrease the danger of infection.

I should like to thank Dr. N. S. Shenstone, who operated upon two of the patients, for the privilege of including them in this report and Dr. Roscoe Graham for his permission to report one of the cases not operated upon. My thanks are also due to the Department of Pathology for the preparation of the photomicrographs and to the Department of Medical Art for the drawings illustrating the operative technic.

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DISCUSSION.—DR. STUART W. HARRINGTON, Rochester, Minn.: I have greatly enjoyed Doctor Lahey's presentation of pharyngo-esophageal diverticulum and wish to compliment him on the excellent results obtained with his two-stage diverticulectomy. I agree with Doctor Lahey's statement that pharyngo-esophageal diverticula may be treated surgically by a one-stage or two-stage operation. I have been interested in this subject for some time. My first experience was with the two-stage operation, which was the method of treatment utilized by Doctor Judd when I assisted him 30 years ago. My own experience consists of 171 of the 348 pharyngeal operations which have been performed at the Mayo Clinic for this condition. Of these 171 operations, the first 25 were done in two stages and the remaining 146 were done as one-stage procedures.

There was one operative death in the 25 cases in which a two-stage operation was performed. A temporary pharyngeal fistula developed in six cases. Paralysis of the left vocal cord developed in one case and repeated dilatation was required in five cases

because of angulation of the esophagus. The average period of convalescence to the time of dismissal was five weeks. Diverticula of moderate size recurred in three cases but repeated dilatation has produced relief and a second operation has not been necessary.

The one death can hardly be attributed to the type of operation as the patient was in very poor general condition because of Parkinson's disease and had almost complete obstruction of the esophagus, which necessitated operation. It is probable that the patient would not have survived any type of operation. I believe that the three recurrent diverticula and the prolonged convalescence in the six cases in which pharyngeal food fistulae developed were due to the technical difficulties of accurately determining the site of the neck of the diverticulum and to delayed healing resulting from the first stage operation. I thought these difficulties would be lessened and the results improved by a one-stage operation.

I have been much gratified with the results obtained in the 146 cases in which a one-stage operation was performed, particularly because mediastinitis has not developed in any case and because the wound healed by primary intention in 92 per cent of the cases. There was no operative mortality. The diverticula recurred in two cases and a second operation was necessary in one. There were five temporary fistulae and one instance of paralysis of the left vocal cord. Repeated dilatation was required in five cases because of angulation of the esophagus. The average duration of convalescence to the time of dismissal was 19 days.

I have been particularly interested in the cases in which the diverticula recurred. In three of the seven cases in which this happened, I believe that one of the reasons for the recurrence was the method of approach to the diverticulum. In these three cases, the approach was through a left cervical incision and the opening of the diverticulum was chiefly on the right side of the hypopharynx. I have found that in a high percentage of pharyngo-esophageal diverticula, the opening is chiefly on the right side of the hypopharynx. In these diverticula, the surgical approach should be made through the right cervical region, because a more accurate dissection of the neck of the sac can be accomplished. Also, there is less danger of leaving a spur at the site of the opening of the diverticulum. A right cervical approach was employed in 34 of the 171 cases.

The chief considerations in determining the relative value of these two operative procedures are the operative mortality, the effectiveness of the procedure in relieving the pathologic condition and the associated morbidity, which is of relatively little importance as compared with the mortality.

I believe that the results obtained with the two types of operation in this series of 171 cases of pharyngo-esophageal diverticula definitely show the value of the one-stage procedure.

I have also enjoyed Doctor Janes' presentation of the treatment of diverticula of the lower part of the esophagus and I agree with his method of surgical treatment by transpleural diverticulectomy. As he has stated, these diverticula are usually situated in the lower fourth of the esophagus and are relatively rare as compared with pulsion diverticula of the hypopharynx, commonly called pharyngo-esophageal diverticula.

I have operated upon four patients who had a pulsion diverticulum of the lower part of the esophagus. In each of the four cases, I performed a one-stage transpleural diverticulectomy. In three of the cases, I was able to excise the diverticulum completely and reconstruct the wall of the esophagus. In one case, it was impossible to excise the diverticulum completely because of extensive calcification of its walls, which was most pronounced at the neck of the sacculation, but it was possible to excise part of the diverticulum, which relieved the obstructive symptoms caused by an angulation of the esophagus just below the diverticulum.

One of the important technical considerations is the inversion of the mucous membrane at the neck of the diverticulum. The technic I have used is to excise the diverticulum with a cautery about 1.5 cm. from the wall of the esophagus and to invaginate

the 1.5 cm. of mucous membrane of the neck of the diverticulum with a continuous mattress suture of chromic catgut. The wall of the esophagus is then closed over this invaginated mucous membrane with interrupted silk sutures. The mediastinal pleura is then sutured over this closed portion of the esophagus.

In the four cases in which I have operated, there have not been any operative deaths. Postoperative empyema developed in one case but drainage was followed by a satisfactory recovery.

I have some slides which show the different locations of the diverticula emphasizing the importance of approaching the right-sided diverticulum through the right cervical incision.

Dr. Robert S. Dinsmore, Cleveland, Ohio: I think it is unfortunate that Doctor Lahey did not have more time to bring out some of the points in this problem. Mention has been made of mediastinitis, but a review of a large series of cases done by either the one- or two-stage operation shows that the incidence of this complication is lower than is generally supposed. Lord Moynihan had early made this observation. Neither essayist made any mention as to the use of a scope at the time of operation. I prefer to do them without a scope in place. I had one experience which impressed me; after closing the neck of the sac in the esophageal wall the scope inadvertently passed through the closed suture line.

I do not think we should disregard the fact that there may be a modified two-stage operation which can be used. If there has been gross contamination, by simply placing a small gauze pack in the area a secondary closure can be done at the end of a 48-hour period. Some of these large sacs, particularly the ones which pass down into the mediastinum, the walls of which become the thickness of paper tissue, may require even more than a two-stage operation. Occasionally one of these may become infected and require more than a two-stage operation. I once helped Doctor Crile with one of these cases, and each time we would open the neck we would get into a sacculated collection of pus. The patient, however, was coöperative, and aided us by inserting about 600 cc. of corn whiskey into the cavity, which apparently helped to sterilize it.

Dr. Frank H. Lahey, Boston, Mass. (closing): Visitors at the Clinic often ask me why we do not leave these cases as they are when the first stage is completed, that is, with the sac suspended. We have done this in four cases and there has been recurrence of the sac enlarging into a dependent position, obstructive, with regurgitation symptoms in all four cases.

Whether you do esophageal diverticula in one or two stages, I am quite sure that how thoroughly you dissect the sac, how carefully you free it of muscle and how accurately you ligate its neck flush with the longitudinal esophagus have a great deal to do with nonrecurrence. We have in the last 60 cases either sutured or tied the sac under good visualization accurately at its junction with the longitudinal esophagus. As stated in the paper, it is easy to ligate them accurately at the second stage; they heal by first intention in most cases, but in a few there has been leakage. It is because of the fact that leakage occurs occasionally after ligature or suture, either in a one- or two-stage procedure, that we have done these all in two stages. I cannot avoid being disturbed by the presence of a large mediastinal cavity when large sacs are removed and the uncertainty of possible leakage exists.

I do not think it at all necessary to use an esophagoscope in operating upon these patients. When you visualize the sac you can do everything without the esophagoscope that you can do with it, and the procedure is much less complicated.

Concerning the cases reported by Doctor Janes in which the diverticulum occurred within the pleural cavity above the diaphragm, we have reported five such cases operated upon with no fatality. Almost all of these patients are elderly. In the article in which these cases were published I reported the method by which the sac can be completely mobilized so that it hangs by the neck and then can be attached to the parietal pleura in the vertebral gutter beside the vertebral bodies, so that the pulled out sac is

exactly parallel with the esophagus and so that in the upright position no food can enter it. We have demonstrated that upon giving patients barium it is possible to get the barium into the sac only with the patient in the Trendelenburg position. This is the method whereby one can overcome the effects of the diverticulum without the danger of possible pleural contamination in these elderly people.

DR. ROBERT M. JANES, Toronto, Ont. (closing): There was no operative mortality in this group, in spite of the fact that one had lymphatic leukemia, one was a morphine addict, and one had bilateral pulmonary tuberculosis.

CARCINOMA OF THE MIDTHORACIC ESOPHAGUS*

ITS TREATMENT BY RADICAL RESECTION AND HIGH INTRATHORACIC ESOPHAGOGASTRIC ANASTOMOSIS

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ANY OPERATIVE PROCEDURE which is intended to be applied in the treatment of carcinoma of the esophagus, at whatever level, must be based upon the two-fold aim of prolongation of life, looking towards the possibility of cure, and the provision of relief from the distress which results from the obstruction produced by the growth.

Until recently the only practical method available for use in the removal of a carcinoma located in the middle half of the thoracic portion of the esophagus was the Torek operation.[1] This procedure has, however, been shown to be unsatisfactory when measured by the above criteria.

In the first respect, the Torek operation is inadequate as a cancer operation. It is a well-established principle in the treatment of carcinoma that in addition to a wide excision of the primary tumor, it is essential to remove as large a number of the regional nodes as possible. If Torek's original technic is followed, two important groups of regional lymph nodes are not removed. These are the subdiaphragmatic paracardial nodes and the group of nodes found in relation to the left gastric vessels. Both of these groups, in addition to those located around the lower thoracic portion of the esophagus, are frequently involved by metastases (Table I). The importance of removing these nodes in the performance of the operation is confirmed by the fact that they were found to be involved in 50 per cent of the cases in this series of 32 radical resections. It is only the lower thoracic nodes which are removed in the classical Torek operation.

TABLE I

CARCINOMA OF THE MIDTHORACIC ESOHPAGUS

Frequency and Distribution of Lymph Node Metastases in 32 Patients who had Resection and Anastomosis

Nodes not involved	9
Nodes involved	23
Hilum of lung	7
Peri-esophageal	15
Paracardial	13
Near left gastric vessels	16

In the second place, the failure of the Torek procedure to provide satisfactory palliation, even if an external esophagoplasty is successfully completed, is obvious to those who have had experience with its use.[2] Table II summarizes the results obtained from the application of the Torek procedure in

*Read before the American Surgical Association, April 2–4, 1946, Hot Springs, Virginia.

TABLE II

EXPERIENCE WITH THE TOREK OPERATION AT THE MASSACHUSETTS GENERAL HOSPITAL

Number of operations	14
Postoperative deaths	2
Survivals	12
External esophagus not begun (all patients dead)	4
External esophagus begun	8
Died before completion	4
External esophagus completed	4
Died subsequently	3
Alive and well	1

14 cases of carcinoma of the midthoracic esophagus. The immediate postoperative mortality is not prohibitive (two cases). But its poor result from the standpoint of cure is evident from the fact that all but one patient have died of metastatic or recurrent disease. The unsatisfactory palliative result is reflected by the fact that of the eight patients in whom an external esophagoplasty was begun, four died of metastases before the procedure could be completed. Of the remaining four in whom the external esophagus was finally established, two died soon after the completion of the surgical program. Of the two who remained well, one has since died and one is alive and well almost six years after the operation. These results are far from satisfactory.

The development of a satisfactory technic for the radical resection of the local disease, including the excision of at least three of the four groups of regional nodes which may be invaded, offers greater promise of producing a cure in these cases. But of equal, if not greater, importance is the fact that after a high primary intrathoracic esophagogastric anastomosis has been performed, the patient is able to swallow normally. The palliation afforded by this procedure, even if death should occur six months to a year, or more, later as a result of distant metastases, makes this operation infinitely superior to the Torek procedure.

DESCRIPTION OF THE OPERATION: ESOPHAGECTOMY FOLLOWED BY HIGH INTRATHORACIC ESOPHAGOGASTRIC ANASTOMOSIS

Intratracheal ether-oxygen anesthesia is used. The patient is placed on his right side with the left arm held forward, the hand in front of his face. The left side of the chest is made to arch upwards by bending the operating table at an angle. Intravenous infusions of saline and transfusions of blood are given as necessity demands during the procedure, using a hand or forearm vein. The incision is started at the left costal margin anteriorly and extends posteriorly over the course of the eighth rib, curving upwards a short distance between the spine and the left scapula. The eighth rib is resected, cutting its neck posteriorly and the cartilage anteriorly. It is usually necessary to divide one or more ribs posteriorly (often the seventh, sixth, and fifth) in order to provide access to a high growth and for the performance of a very high anastomosis. The wound edges are protected with large gauze pads, a rib-spreader is inserted, and the lung is retracted using a Harrington retractor over a protecting pad of gauze.

The resectability of the growth must be determined next. The mediastinal pleura is incised and the dissection is begun anterior to the esophagus, so as to free the attachments of the growth to the structures in the hilum of the lung. At this point, invasion of the left main bronchus, extensive involvement of the region around the inferior pulmonary vein, or fixation to the aortic arch may make it impossible to remove the tumor. If the adhesions to these structures can be divided safely, the dissection of the posterior attachments is then begun. This step in the procedure is left until last so as to avoid interference with the blood supply to the midesophagus which would result from dividing one or more of the esophageal arteries which arise from the aorta. Extensive fixation to the aorta or actual invasion of its wall makes it necessary to abandon the operation in some cases. After the posterior attachments are divided, the growth must be freed from the right mediastinal pleural reflexion. In many cases it is necessary to excise a portion of this pleural layer, thus, leaving a wide opening into the right thoracic cavity. The anesthetist's closed system makes it possible to prevent collapse of the right lung by exerting positive pressure and no attempt need be made to close the right pleural cavity. In the majority of such cases the defect is too large to be closed and after the left lung has been expanded and the chest closed, no ill effects have been observed as a result of leaving it open. It was necessary to open the right pleural cavity in 13 of the 32 cases reported. No complications which could be attributed to this occurrence were observed. In a few cases small portions of the adjacent lower lobe of the right lung have been removed because of fixation to the growth at that point. The defect in the surface of the lung is closed with a running suture of fine No. 00 catgut on an atraumatic needle.

After the esophagus has been dissected free from the level of the aortic arch downwards to its fullest extent, the abdomen is entered by incising the diaphragm from the insertion at the costal margin through the esophageal hiatus. The phrenic nerve is crushed to maintain immobility of the diaphragm. The numerous branches of the phrenic artery which are severed in the making of this incision are then tied with suture ligatures. The upper two-thirds or more of the stomach are then freed in order to make it possible to move the fundus to a high level within the chest for the anastomosis. The gastrolienal ligament is divided and the left gastro-epiploic vessels and the vasa brevia are cut and tied. The spleen is protected with gauze and retracted. The gastrocolic omentum is divided as far as the pylorus, taking care to avoid injury to the right gastro-epiploic vessels. The attachments of the cardia and lower esophagus are then cut, including several small vessels which are branches of the superior suprarenal, inferior phrenic, and pericardiophrenic vessels. The gastrohepatic ligament is cut next. Occasionally an artery of appreciable size is encountered in this structure. This vessel is an hepatic branch of the right inferior phrenic artery. Finally, the left gastric vessels are cut and tied close to the origin of the artery from the celiac axis. After this vessel has been severed, the fundus of the stomach can be placed without difficulty in the apex of the chest (Fig. 1, insert).

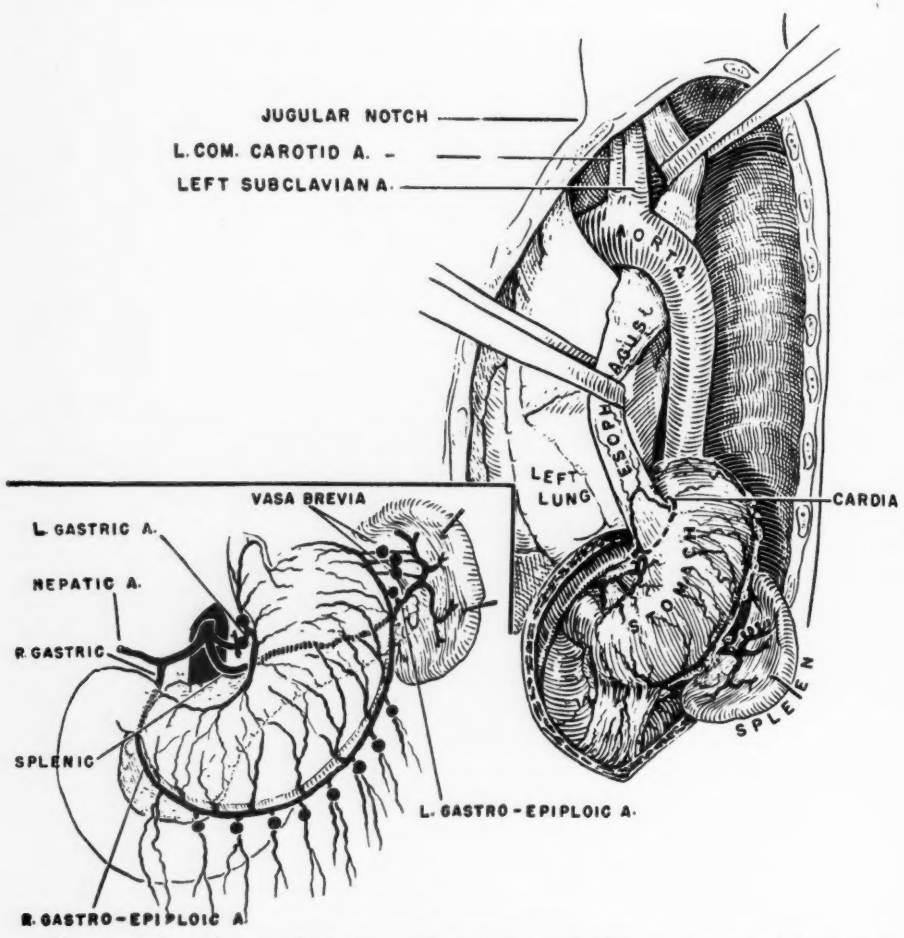

FIG. 1.—Dissection required for esophagectomy and high supra-aortic intrathoracic esophagogastric anastomosis. Complete mobilization of the esophagus to the apex of the chest. Mobilization of the stomach leaving only the right gastric and gastro-epiploic arteries. Inset: Large dots show the blood vessels which must be severed.

The stomach is now divided between clamps just distal to the cardia in such a way as to make it possible to remove the lymph nodes located around the lower esophagus and cardia and those in relation to the left gastric vessels. The distal portion is inverted by means of two layers of continuous sutures of fine chromic catgut reinforced with a layer of interrupted silk sutures. A rubber glove is tied over the lower end of the esophagus.

After the mobilization of the stomach has been completed, an incision is made in the mediastinal pleura above the aortic arch. The portion of the esophagus which lies in the superior mediastinum is now freed by blunt dissection and a piece of Penrose drain is passed around it for traction. By dissection, now from above, now from below, the attachments of the esophagus behind the aortic arch are freed. At this point, several small arteries, some

of which arise from the aorta and some from the bronchial arteries, must be divided. These constitute the last of the esophageal blood supply which arises from within the chest itself. If the growth is very adherent behind the aortic arch, greater exposure may be obtained by cutting the upper one or two left intercostal arteries. The aortic arch may then be retracted forwards sufficiently to complete the dissection behind it. The thoracic duct may be encountered behind or just above the aortic arch at this level. It should be carefully sought for and tied if injured or if it is necessary to resect a portion which may be adherent to the tumor. After the esophagus has been freed in this way, it may be pulled up from behind the aortic arch and turned outwards in a position convenient for the performance of the anastomosis (Fig. 2).

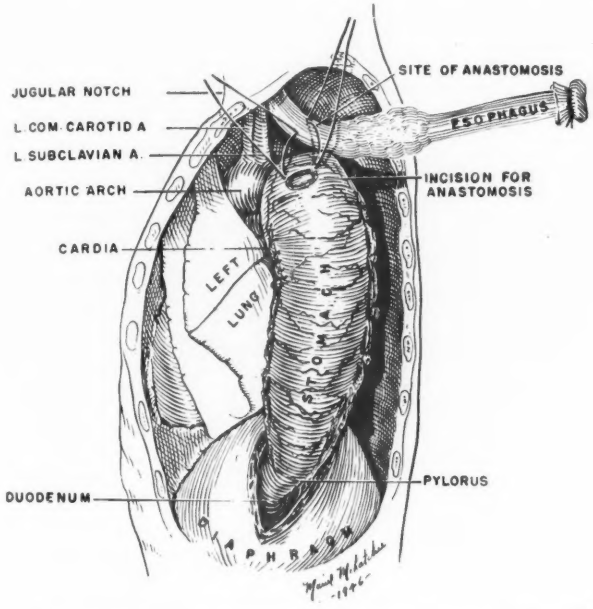

FIG. 2.—Stomach and esophagus completely mobilized and in position for the performance of anastomosis above the aortic arch.

In some cases where the upper limits of the tumor do not extend quite as high as the inferior margin of the aortic arch, dissection behind and above the arch is avoided and the anastomosis is performed just below the arch.

At a high level on the fundus of the stomach a circular incision of appropriate size is made through the serosal and muscular coats. The small vessels which cross this incision in the submucosal layer are tied with suture ligatures of fine silk in order to diminish the amount of bleeding during the performance of the anastomosis. A suitable site for the anastomosis is then chosen several centimeters above the upper limits of the growth, and an outer layer of mattress sutures comprising the first layer of the posterior half of the anastomosis is placed and tied (Fig. 2). A Wertheim clamp is then

put on the esophagus several centimeters distal to the site of anastomosis and with a right-angle knife blade (Beaver blade No. 14) the muscularis of the posterior esophageal wall is incised. The resulting muscle edge of esophagus is then sutured to the muscle edge of the stomach. The posterior half of the esophageal mucosa is then incised and the circular portion of stomach outlined by the initial incision through the serosa and muscularis is excised. The gastric contents are aspirated. The posterior mucosal layer of sutures is then

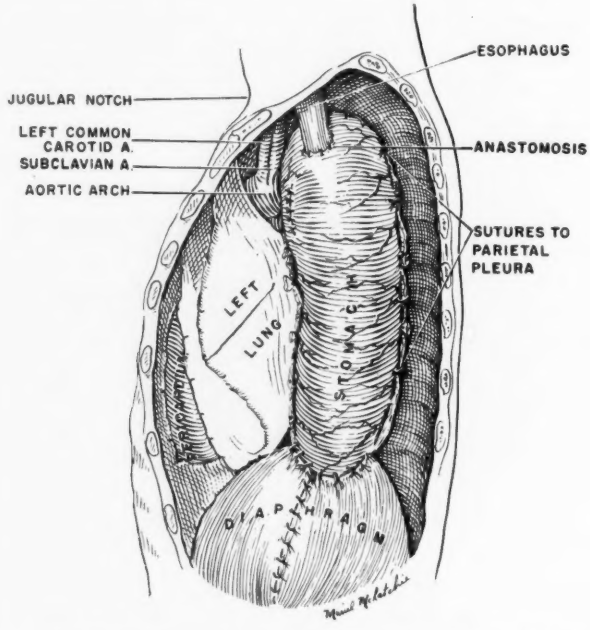

FIG. 3.—Operation completed; anastomosis established; stomach fastened in the chest by sutures to the parietal pleura; diaphragm closed.

applied. With a pair of scissors having bent blades the anterior wall of the esophagus is cut across and the segment to be excised is removed. The anterior aspect of the anastomosis is then completed with three layers of sutures. Fine silk is used throughout. A series of interrupted sutures is used to fasten the stomach to the parietal pleura so as to relieve the pull upon the anastomosis. The edges of the diaphragm are then fastened to the antral portion of the stomach where it passes through and the remainder of the edges of the diaphragm are approximated (Fig. 3).

A solution of penicillin containing 50,000 units is injected partly above and partly below the diaphragm before its closure is complete. A catheter for closed suction drainage is brought out through a short incision in a lower interspace posteriorly and the wound is closed by a careful anatomic approximation of its layers using interrupted silk sutures. The lung is fully expanded before closure of the chest is completely air-tight.

IMPORTANT DETAILS OF TECHNIC

(1) *Immobilization of the Stomach:* The extensive dissection described, including division of the gastrocolic, gastrolienal, and gastrohepatic ligaments, the left gastro-epiploic, and the left gastric arteries and vasa brevia, is required in all cases where the high level of the tumor makes it necessary to place the fundus of the stomach above the level of the aortic arch. A further reason for cutting the left gastric artery at its origin from the celiac axis is the necessity for removing all the lymph nodes which are grouped about the ascending branches of this vessel.

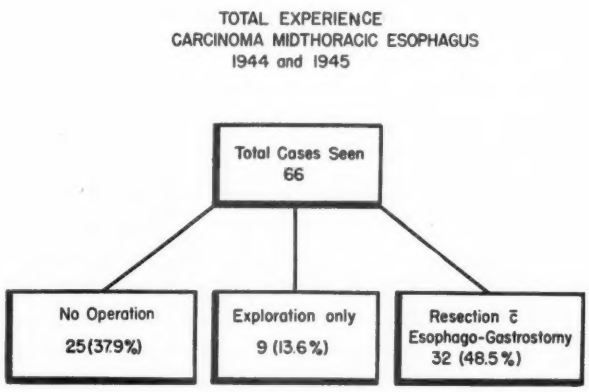

CHART I

(2) *Preservation of the Blood Supply:* (A) At the completion of the operation the stomach is dependent for its blood supply upon the flow from the right gastric and right gastro-epiploic arteries. The nutrition of the tissues at the site of the anastomosis high in the apex of the fundus depends primarily upon the preservation of a continuous arcade of vessels through the gastro-epiploics on the greater curvature side and the anastomoses between the branches of the right and left gastric arteries on the lesser curvature side. Of utmost importance, likewise, is the maintenance of the integrity of the intercommunicating vessels within the wall of the stomach which connect these two primary sources of supply. It is these vessels upon which the viability of the gastric wall at the site of the anastomosis is completely dependent. It is necessary, therefore, in handling the stomach throughout the entire operation to exert every effort to avoid trauma to its wall and to the vessels which course within it. A tear produced by a forcep or a clamp or an hematoma resulting from careless handling might be the determining factor in the occurrence of an unfavorable outcome.

(B) Preservation of an adequate blood supply to the site of anastomosis on the esophageal side depends upon a knowledge of the segmental nature of its blood supply. If the anastomosis can be made just below the aortic arch,

the integrity of the small arteries arising from the arch and from the bronchial arteries insures adequate nutrition of the tissues at the cut-end of the esophagus. If, however, it becomes necessary because of the high extent of the tumor to dissect the esophagus further and to pull it up from behind the aortic arch, the benefit of these vessels is sacrificed and the only remaining blood supply to the esophagus is that which descends from the inferior thyroid artery. It follows, therefore, that when the esophagus has been pulled out from behind the aortic arch it must always be divided at a high level within the chest in order to avoid necrosis of its cut-end at the anastomosis site. This must be kept in mind when there appears to be a relatively long, uninvolved portion above the tumor after the dissection has been carried out. Although it is more difficult from a technical standpoint to divide the esophagus high under these conditions, it may mean the difference between success and failure in the outcome of the operation.

(3) *Management of the Thoracic Duct:* If, as in the majority of cases, it is necessary to carry the dissection above the aortic arch, the thoracic duct may be encountered where it crosses the esophagus to assume a more anterior position behind the subclavian artery. If the growth lies in this region, the duct may be adherent to it or actually invaded, making it necessary to excise a segment. In some cases, after the esophagus has been dissected out, the thoracic duct may be seen loosely draped across the empty space left in the superior mediastinum. Under such conditions there is danger that the thinned-out or actually traumatized wall of the duct will result in leakage of chyle. In either case, it is important to tie the thoracic duct to prevent such an occurrence.

In the 32 cases reported, the thoracic duct was tied and divided in three, with no ill effects. In a fourth case, the duct was injured but through an oversight it was not tied. This patient died subsequently as the result of a persistent chylous hydrothorax.

(4) *Avoidance of Stricture at the Anastomosis:* Prompt and accurate healing of the layers of the anastomosis, especially the mucosa, is necessary to avoid extensive cicatrization and the resultant stenosis which follows the contraction of scar tissue. To accomplish this, all unnecessary trauma to the edges used in the anastomosis must be avoided. Measures which should be adopted to minimize the amount of trauma to these edges are (a) avoidance of the use of crushing clamps on either the gastric or esophageal side; (b) the utilization of knife and scissors to cut the esophagus and stomach instead of the cautery or a chemical caustic, such as carbolic acid on a knife; and (c) the use of interrupted fine sutures instead of running sutures which tend to constrict uniformly the edges of the entire circumference of the anastomosis and, thus, produce necrosis which results in delayed healing. The utilization of a circular opening in the stomach wall for the anastomosis may be of some further importance.

EXPERIENCE WITH CARCINOMA OF THE MIDTHORACIC ESOPHAGUS IN 66 CASES SEEN DURING 1944 AND 1945

The first resection and high intrathoracic esophagogastric anastomosis above the aortic arch for carcinoma of the midthoracic esophagus at the Massachusetts General Hospital was performed early in 1944. Since then, this procedure has been used in these cases in place of the Torek operation.

Operability: During 1944 and 1945, 66 cases of carcinoma of the middle half of the esophagus were observed (Table III). Of these, 25 were considered to be inoperable because of their extremely poor general condition.

TABLE III

CARCINOMA OF THE MIDTHORACIC ESOPHAGUS

Operability—1944 and 1945

	No.	Per Cent
Total cases seen	66	
Cases operated upon	41	62.1
Resection performed	32	48.5
Total cases operated upon	41	
Exploration only	9	22.0
Resection with anastomosis	32	78.0

The majority of these died within a few weeks of the time they were first seen at this hospital. Forty-one patients, however, were operated upon after adequate, often prolonged preoperative preparation to improve their nutritional status. Of this number, nine were found to have tumors which could not be removed. In the remaining 32 cases a radical resection followed by high intrathoracic esophagogastric anastomosis was performed. Thus, of the total number of patients seen 62 per cent were operated upon, and it was possible to perform a radical operation in 48.5 per cent. Of the total number of patients operated upon, 78 per cent were given the benefit of resection (Table III). This high resectability is the result of a policy in the management of these cases which is calculated to provide a worth while degree of palliation for as many patients as possible by always removing the growth unless there is a serious technical obstacle which prevents it.

Inoperable Cases Explored: In nine cases it was impossible to remove the growth because of extensive local fixation and invasion of important structures, such as the aorta, the bronchus, or the inferior pulmonary vein. Eight of these patients made an uncomplicated recovery following the exploratory thoracotomy and left the hospital. One died of widespread lymphatic invasion of both lungs while still in the hospital. The majority of the remaining patients died within a few months after exploration.

Cases of Resection Followed by Anastomosis.—Age of Patients: Before taking up the consideration of the results of resection, it is important to bear in mind that a very large percentage of the patients upon whom a resection and high anastomosis was performed were old. Table IV illustrates the age distribution. It is noteworthy that over one-half of the patients (19 in all) were 65 years of age or older. Five of these were 70 or more.

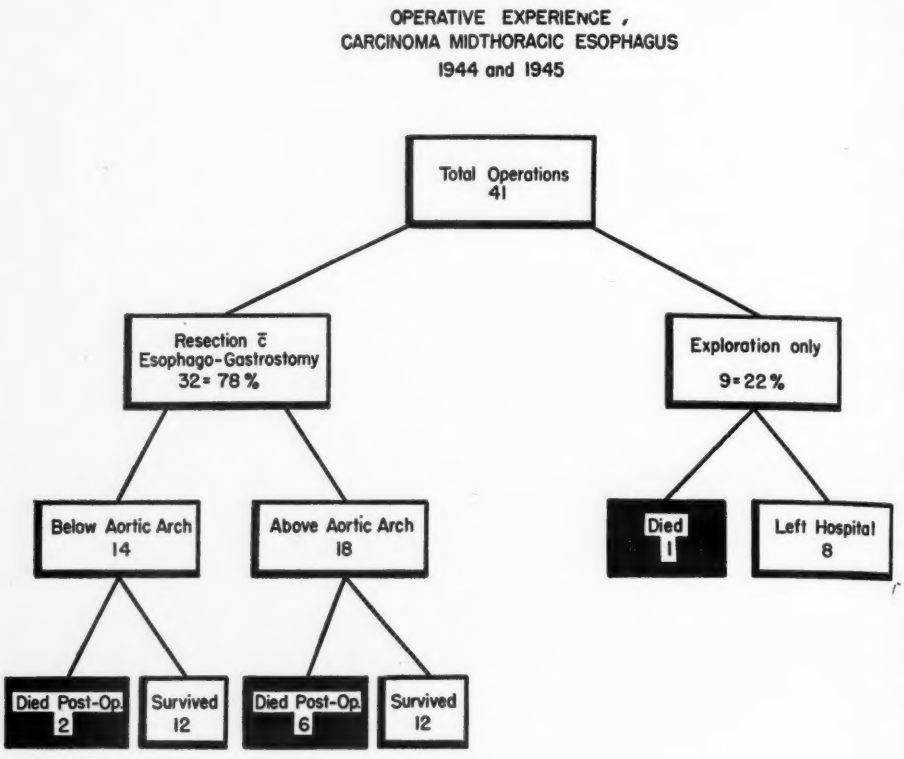

Chart 2.

Distribution According to the Level of Anastomosis: Of the 32 patients who had an esophagectomy carried out, it was possible to perform the anastomosis just below the aortic arch in 14. But in the remaining 18 cases it was necessary to dissect the esophagus from behind the aortic arch and perform the anastomosis above the arch (Chart 2). The importance of this is reflected in an analysis of the frequency of complications and postoperative deaths.

TABLE IV

AGE DISTRIBUTION OF RESECTION CASES

40–45	1
45–50	2
50–55	2
55–60	3
60–65	5
65–70	14
70, or over	5

For example, of the 13 cases in which complications developed, ten were in the group where the anastomosis was performed above the aortic arch and only three were in the group where the anastomosis was carried out just below the arch. Likewise, the number of postoperative deaths was much larger in

TABLE V

CARCINOMA OF THE MIDTHORACIC ESOPHAGUS (32 CASES)

Complications Following Resection with High Esophagogastric Anastomosis

Complication	Subaortic Anastomosis	Supra-aortic Anastomosis	Total
Cardiac Disorders:			
Congestive failure	0	4	4
Myocardial infarction	1	0	1
	1	4	5
Manifestations of Infection:			
Wound sepsis	0	1	1
Empyema	0	1	1
Mediastinitis	0	1	1
	0	3	3
Chylous hydrothorax	0	2	2
Pulmonary embolus (sublethal)	1	0	1
Pulmonary atelectasis	1	0	1
Surgical shock	0	1	1
Total	3	10	13

the former group than in the latter (six cases as compared with two cases). The explanation of these observations lies in an appreciation of the fact that the higher the lesion is, the greater the amount of dissection required and the more the trauma which results. The supra-aortic anastomosis group, in addition to the hazards of a larger amount of dissection in the mediastinum close to the heart and other vital structures there, is subjected to a longer procedure and to the hazards of a more difficult anastomosis.

Analysis of the Complications and Causes of Death Occurring after Resection: Tables IV and V enumerate the complications and causes of death which

TABLE VI

CARCINOMA OF THE MIDTHORACIC ESOPHAGUS (32 CASES)

Causes of Death Following Resection with High Esophagogastric Anastomosis

Cause	Subaortic Anastomosis	Supra-aortic Anastomosis	Total
Cardiac Disorders:			
Congestive failure	0	3	3
Myocardial infarction	1	0	1
	1	3	4
Sepsis:			
Empyema	0	1	1
Mediastinitis	0	1	1
	0	2	2
Chylous hydrothorax	0	1	1
Pulmonary atelectasis	1	0	1
Total	2	6	8 (25%)

developed in the group of 32 patients who were subjected to resection and high intrathoracic esophagogastric anastomosis.

Cardiac Disorders: As might be expected, the greatest incidence of cardiac disorders was in the group of patients who had a supra-aortic arch anastomosis. Four of this group developed congestive failure and three of these died. Myocardial infarction developed in one patient of the subaortic anastomosis group. This patient died.

Manifestations of Infection: Only three patients of the entire series developed sepsis. In all three cases the difficulty arose in the group of patients

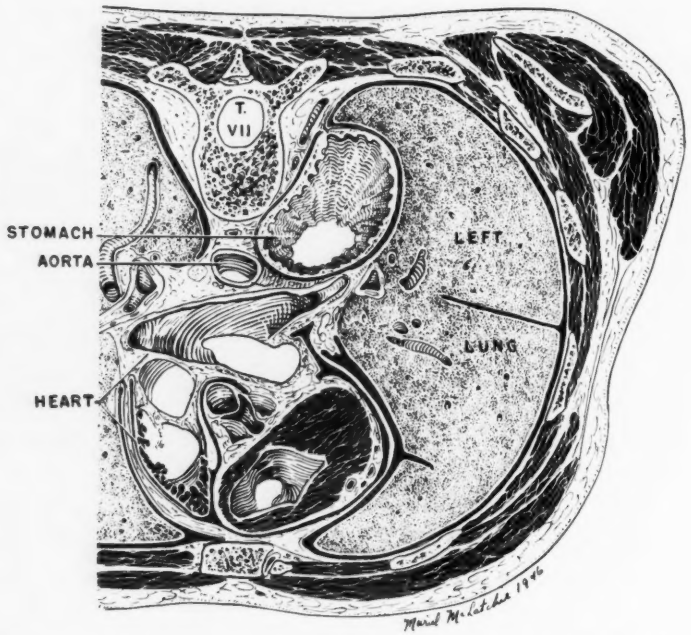

FIG. 4.—Cross-sectional relations of viscera at level of thoracic vertebra VII, showing stomach behind the hilum of the lung.

who were operated upon in 1944, before penicillin was available for civilian use. Since penicillin has been used routinely as a prophylactic measure, there have been no manifestations of infection of any kind in 29 consecutive cases. *Major wound sepsis* occurred in one case. The organism was *Staphylococcus aureus.* A special grant of penicillin was obtained, as a result of which the infection was brought under control. *Empyema* developed in one case. Penicillin could not be obtained. Drainage was established by rib resection but the patient, who was elderly and in poor general condition, died. The third case of infection was a severe and ultimately fatal *mediastinitis* resulting from accidental perforation of the growth during the process of dissection behind the aortic arch in a case which was practically inoperable.

Chylous hydrothorax developed in two cases. Both occurred in the right side of the chest. In each case a portion of the right mediastinal pleural reflexion had been removed. In one, the accumulation was gradual and never very large in amount. It developed several weeks after the operation and was probably the result of involvement of the thoracic duct by carcinoma arising in lymph node metastases within the mediastinum. The patient left the hospital and died a few months later of metastatic disease. This case appears in Table IV but not in Table V. In the other case the chylous effusion developed during the first few days after the operation and resulted in the death of the patient. It was in this case that the injury to the thoracic duct was observed at operation, but through an oversight the duct was not tied. In both these cases a supra-aortic anastomosis was performed.

A *sublethal pulmonary embolus* occurred in one patient. Immediate bilateral superficial femoral vein ligation was resorted to, and no subsequent emboli developed. The patient recovered and has had no difficulty with his legs since the ligation was performed.

Pulmonary atelectasis developed on the left side in one elderly woman who had an emphysematous chest with a marked kyphosis. Bronchoscopic aspiration failed to produce permanent relief and the patient died on her 4th postoperative day.

Transitory surgical shock occurred in one patient. It responded to the usual methods of treatment.

SUMMARY

The inadequacy of the Torek procedure from the standpoint both of cancer cure and of palliation in unfavorable cases has made it necessary to abandon the procedure after a trial of 14 cases.

Recent experience has demonstrated the superiority, in each respect, of resection followed by a high intrathoracic esophagogastric anastomosis placed either just below or actually above the aortic arch. This technic is applicable in any case when the growth is located in the middle half of the esophagus, even in cases where the tumor extends upwards behind the arch.

A report of experience in the use of this procedure in 32 cases of carcinoma of the midthoracic portion of the esophagus is given. The technic of the procedure and the complications and causes of death are discussed.

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DISCUSSION.—DR. HAROLD W. WOOKEY, Toronto, Ont.: I have been very much interested in Doctor Sweet's paper on the treatment of cancer of the midthoracic esophagus. A good many of us have operated upon such cases using some modification of the original Torek procedure, but there is no question that patients who try to exist with an esophageal fistula and a gastrostomy are in a most unhappy state. Conse-

quently, it would seem that some method of reconstruction of the esophagus is an essential part of treatment.

Many such methods have been described. The simplest of these is a reconstruction by means of a tube of skin in front of the sternum. This method has necessitated multiple operations, tedious not only for the patient but for the surgeon. It would seem, therefore, that the intrathoracic reconstruction offers many great advantages. In cases in which the growth occurs low down in the esophagus, this procedure may be relatively simple. However, in cases of midthoracic esophageal cancer such growths lie at least in part behind the arch of the aorta, and separation of the tumor when approached from the left side has to be done blindly. One should remember the relations of the vena azygos major, which may be closely adherent to the tumor and, in one case in my experience, an injury of this vessel led to an uncontrollable hemorrhage.

The procedure of bringing the upper end of the esophagus over the arch of the aorta into the left side of the chest enables one to do an anastomosis which would be otherwise impossible. I am showing a slide illustrating such a case in which this has been carried out successfully and the patient has done very well. However, it sometimes happens that the growth is just too high in the esophagus for an intrathoracic anastomosis and too low to be reached through the neck. In such a case I have found it necessary to completely remove the thoracic esophagus and to bring out the upper end in the neck. I should like to refer to the use of a skin tube in reconstruction of the esophagus and am showing a slide of a roentgenogram taken of such a patient on swallowing barium. This slide shows the barium passing down a skin tube in front of the sternum and emptying freely into the stomach. This man was operated upon eight years ago and has remained perfectly well ever since. The skin tube has functioned perfectly and has never required any special care.

One sometimes has difficulty with a fistula developing along the line of the skin tube and this fistula may be difficult to close. I am showing a photograph of a patient in which this occurred. Operation was carried out three years ago. By means of a specially devised rubber obturator the fistula has been closed and the patient has been able to take normal food, and has remained perfectly well.

The future, no doubt, will decide whether the intrathoracic reconstruction will eventually replace other methods. This will depend on the relative mortality rates and also on the function of the intrathoracic anastomosis over a period of years.

DR. FREDERICK L. REICHERT, San Francisco, Calif.: I should like to mention that our resident, Doctor Menke, was able to bring up the stomach and anastomose it above the arch of the aorta because he did what Dr. J. M. T. Finney, Sr., demonstrated—mobilization of the duodenum. Certainly, if you ligate the proper vessels of the stomach and mobilize the duodenum adequately you can bring it up above the arch successfully. I mention that as a means of doing an esophageal gastric anastomosis without a plastic loop of the jejunum.

DR. RICHARD H. SWEET, Boston, Mass. (closing): I wish to thank Doctor Wookey and Doctor Reichert for their discussions. I am eager to discuss this problem with Doctor Wookey because there is one region of the esophagus which remains to be conquered—that which lies above the aortic arch and behind the jugular notch. Doctor Reichert's comment about the advantage of mobilizing the duodenum is proper. This was described several years ago by Doctor Phemister and has been practiced by many. There has been considerable doubt in the minds of some surgeons about the advisability of dividing the left gastric vessels. Of course, it is essential in this operation. I have done it in many cases. By so doing we are better able to remove lymph node metastases, and, with care, one can preserve the blood supply so that the apex of the fundus can be brought to the top of the thorax.

BRONCHIOGENIC CARCINOMA*

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RAPID ADVANCES have been made in the technic of surgical resection for the eradication of primary pulmonary cancer since Graham reported the first successful total pneumonectomy for carcinoma in 1933. Thereafter a commendable optimism began to appear, with published reports of successful cases, or series of cases. To date, however, too few surgeons have indicated the background of case material from which their occasional therapeutic successes have been derived. Considered in this light, the comprehensive picture of therapy for bronchiogenic carcinoma is still a disappointing one and constitutes a challenge to further efforts.

It is the author's purpose to relate his own experience with a consecutive series of 100 primary pulmonary cancers seen within a five-year period, ending December 1943, at the New Haven Hospital, which is a general hospital of about 500 beds.

VITAL STATISTICS.—There were 82 male and 18 female patients, a ratio of 4.5 to 1. Ninety-nine were white and one negro, an expected racial distribution since the State of Connecticut has a negro population of 1.9 per cent, according to the 1940 census. The average age of all patients was 54.8 years. In this decade occurs the peak incidence of nearly all visceral cancer. The youngest patient was 22 years of age. There were five cases in the fourth decade, 21 in the fifth, 41 in the sixth, 28 in the seventh, and four patients were older than 70.

SYMPTOMATOLOGY.—The first observed symptom was usually cough, pain in the chest, or a grippe-like "cold." Sixty per cent of the cases began with one of these three complaints. Six had early dyspnea. Only four patients noted hemoptysis or bloody sputum as an *early* complaint. Three had an acutely pneumonic onset. Nine patients had vague general complaints of weakness and weight loss, and 14 had initial symptoms frankly related to metastases or extensions of tumor beyond the lung.

The average duration of symptoms prior to hospital admission was 6.7 months in 98 cases; two cases were unable to evaluate the time of onset. The inoperable cases had an exactly similar average duration. The presumably operable group, which was subjected to surgical exploration, had a slightly longer duration of symptoms, rather than a shorter one.

LOCATION OF THE PRIMARY LESION.—The right lung was affected 51 times and the left 47. This is approximately the normal ratio of the two lungs in

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terms of volume and respiratory capacity. The upper lobes, together with the stem bronchi above the upper lobe orifice, were involved in 69 per cent. In one bilateral lymphatic lesion and one essentially mediastinal case, the primary focus defied localization.

TABLE I

BRONCHIOGENIC CARCINOMA

Symptoms

First Symptom:

Cough	27	Bloody sputum	4	Hoarseness	1
Pain in chest	21	"Pneumonia"	3	"Indigestion"	1
"Cold" or "grippe"	12	Headache	2	Wheeze	1
Weight loss and weakness	9	Pain in back	2	Not reported	3
Dyspnea	6	Pain in abdomen	2		
Pain in shoulder	5	Dysphagia	1	Total	100

Average duration of symptoms prior to admission:

Entire group (98 of 100 cases reporting)	6.7 months
Inoperable (68 cases)	6.7 months
Presumably operable and explored (30 of 32 reporting)	6.8 months
Resected group (12 cases)	7.2 months

TABLE II

BRONCHIOGENIC CARCINOMA

Location

	Right	Left	Total	
Proximal or diffuse	3	10	13	Proximal
Upper lobe	28	28	56	Upper
Lower lobe	18	9	27	Lower
Middle lobe	2	—	2	Middle
	51	47	98	

Bilateral lymphatic	1
Mediastinal	1
Total	100

TISSUE DIAGNOSIS.—Positive tissue diagnosis was obtained in 82 cases, 77 in the living and five at autopsy of terminal cases. In the remaining 18 no tissue diagnosis was made, either because various methods failed, or because the patient refused the indicated procedures. In this group the clinical course was typical and all 18 subsequently died. In 29 the verification of metastases by biopsy gave simultaneously a tissue diagnosis, and a determination of inoperability.

Thoracoscopy proved itself of practical value in only two cases. Where a massive effusion was present, a microscopic examination of sediment from the fluid was easier and more frequently positive.

It is noteworthy that in 20 cases of 32 explored, operation was approached without a positive tissue biopsy, and with only a presumptive clinical diagnosis. In 10 of the 12 resections this also proved to be the case. If any support

is needed for the concept of exploratory thoracotomy in doubtful lesions, it will be found in these facts.

Needle biopsy of the lung was used successfully in five cases. Three of these were obviously inoperable; the other two were explored and found inoperable. In this clinic needle biopsy has been reserved for inoperable lesions where bronchoscopy, lymph node biopsy or other technics fail, and verification is desired before radiation therapy is begun. A negative needle biopsy has not been considered conclusive in any case.

Histologically, the tumors were classified as squamous or epidermoid (28); adenocarcinoma (11); or anaplastic (35). In eight cases, the type of tumor was not classified except as bronchiogenic carcinoma. In the squamous and anaplastic groups, the expected sex ratio of five or six to one was maintained. In the adenocarcinoma group the sexes were evenly represented. All of the cases under 40 years of age in which the type was specified were adenocarcinoma. These considerations suggest a different etiologic background, perhaps in congenital lesions or adenomata for the adenocarcinoma type.

TABLE III

BRONCHIOGENIC CARCINOMA

Tissue Diagnosis

Negative	18
Positive	82
At autopsy	5
In living patient	77
	100
Method by which first made:	
Bronchoscopy	28
Lymph node biopsy	10
Thoracotomy and biopsy	10
Resection of lung	10
Sedimentation of pleural fluid	5
Needling of lung	5
Thoracoscopy	2
Biopsy of metastases	7
(CNS 2, skin 1, thyroid 1, bone 2)	
	77

THERAPY STATUS.—Sixty-five patients were found to be inoperable when first seen, and three refused treatment. Of the 65, 36 were proven by biopsy of metastases, or by involvement of important nerves; in three, the tumor was present at the tracheal carina or invading the trachea. In 18, presumptive evidence of inoperability, such as roentgenologic or bronchoscopic evidence of marked mediastinal distortion, was considered sufficient grounds for refusing exploration. Seven patients were moribund or with other lethal conditions. One patient had had radon treatment elsewhere: there was no bronchoscopic or roentgenographic trace of the original lesion, but he died four months subsequently of metastases.

Surgical exploration was carried out in 32 cases (one in another hospital). Twenty of these were found to have extensions to the hilar mediastinum (12 cases), to remote mediastinal nodes (2 cases), or dissemination to the

parietal pleura (6 cases). *Local* extension to the parietal pleura was not considered a contraindication to resection, a block resection of the locally involved area being performed in several cases.

Of the 12 resections, ten were total pneumonectomies and two total upper lobectomies. In the group of resections, ten were considered to be complicated cases. One case was complicated by putrid abscess. Three had local parietal pleural extension. One had tuberculous hilar nodes; one an obstructive pneumonitis with pneumococcal empyema. One case had massive pleural effusion

TABLE IV

BRONCHIOGENIC CARCINOMA

Therapy Status

Inoperable	65
Refused treatment	3
Presumed operable and explored	32
Not resectable	20
Resected	12
Pneumonectomy, total	10
Lobectomy, total	2
Total	100

TABLE V

BRONCHIOGENIC CARCINOMA

Reasons for Inoperable Status

Metastases, proven to:		Metastases or extension, *presumed* to:	
Regional nodes	10	Mediastinum	14
Pleura	7	(X-ray findings	8)
Bone	7	(Bronchoscopic distortion	6)
Mediastinum	5	Other lung (x-ray)	2
(Recurrent nerve paralysis	2)	Pleura (effusion)	1
(Horner's syndrome	1)	Adrenals (masses)	1
(Phrenic nerve paralysis	1)		—
(Vena cava obstruction	1)	Subtotal	18
Central nervous system	2		
Chest wall	1		
Esophagus	1		
Skin	1		
Thyroid	1		
Trachea	1		
	—		
Subtotal	36		

Terminal state or lethal complications	7
Proximity to trachea by bronchoscopy	3
Previous radon treatment	1
Refused treatment	3
Total	68

without gross pleural tumor involvement. Two had hilar (intertracheal) nodes invaded by tumor. One was suspected of contralateral metastases, proven by subsequent developments. Only two were considered to be entirely free of complications.

No patient was refused surgery because of age alone. The oldest resection was at age 68. The average age of the resected cases was 54.0, as compared with 54.8 for the entire series.

RESULTS OF TREATMENT.—In 38 cases which received only diagnostic and symptomatic care, the briefest life-span after diagnostic admission to this hospital was one month and the longest 36 months; the average was 5.0 months.

Twenty-nine cases received high voltage roentgenotherapy, radon implantation, or both. All of these are dead; the shortest life-space was two months and the longest 33. The average duration of life in this group was 7.4 months, an increase of doubtful significance over the untreated cases. However, in this treated group there was a very significant palliation in the form of pain relief, decrease of dyspnea, improved aeration and bronchial drainage, as well as psychotherapeutic benefit.

In the 20 cases submitted to unsuccessful exploration there were no operative or hospital deaths. Nine of these had no subsequent roentgen ray treatment, and the average life-span was 8.0 months. Eleven subsequently treated by roentgen ray lived an average of 11.8 months. This difference is not statistically significant.

TABLE VI

BRONCHIOGENIC CARCINOMA

Present Status

DEAD—96

Duration of life after date of first admission

	Cases	Mean	Extremes	"t"	"P"
No special treatment	38	5.0 months	1—36/	1.56	0.15
Roentgen or radon therapy	29	7.4 months	2—33/		
Exploratory thoracotomy	9	8.0 months	2—26/	1.09	0.3
Exploration and roentgenray	11	11.8 months	6—28/		
Pneumonectomy: Hospital deaths	3	1.3 months	0— 2		
Later deaths	6	12.3 months	3—26		

LIVING—4

Pneumonectomy	2 (1, 5.5 years; 1, 4 years)
Lobectomy	1 (2 years and 3 months)
Roentgenotherapy	1 (3 years and 4 months

Three patients died in the hospital following total pneumonectomy (30% of the ten total pneumonectomies, 25% of the 12 resections). In summary, one patient aged 60, died 12 days postoperatively of aortic thrombosis and cardiovascular failure due to arteriosclerosis. One patient, aged 65, died with bronchial fistula and empyema at six weeks. One, age 53, succumbed with metastases while still in the hospital, two months after resection.

Six cases successfully submitted to resection have died subsequently of metastases at intervals ranging from three to 26 months postoperatively; the average survival was 12.3 months.

Four patients are living. One pneumonectomy case survives 5.5 years after resection, which included a block resection of the involved chest wall; the microscopic diagnosis was squamous cell carcinoma. The patient, a female Negro, then age 46, has recently recovered from pneumonia of the remaining right lung and is well. Another pneumonectomy case survives in good health 4.5 years after one-stage resection of the right lung for squamous cell carci-

noma in the presence of an encapsulated pneumococcal empyema; the latter was sterilized by sulfonamide chemotherapy. His attained age is 68, and he operates his own farm. One lobectomy case, age 70, is living without evidence of disease at two years and six months. The pathologic diagnosis was squamous cell carcinoma. One patient with anaplastic carcinoma in the mediastinum is living and working three and one-half years after roentgen ray treatment. He is the only radiation treatment case in which a strikingly lasting effect has been obtained. It is to be emphasized that two of the three surviving resections were complicated cases. All three were squamous cell tumors.

In addition, two patients with solitary metastases of carcinoma, from uterus and urinary tract, respectively, were treated by pneumonectomy with survivals of 24 and five months, respectively. They are not included in the statistical summary.

SUMMARY

1. An unselected series of 100 primary bronchiogenic carcinoma cases, which were seen in a general hospital service, has been analyzed statistically.

2. Sixty-five patients were considered hopelessly advanced and found inoperable when first admitted. Three refused treatment.

3. Surgical exploration was performed in 32 cases. No positive tissue diagnosis was available in 20 of these cases despite various diagnostic studies. Twenty of the 32 patients were found not suitable for resection at the time of exploration. There was no hospital mortality in this group.

4. Twelve patients were submitted to surgical resection (ten pneumonectomy, two lobectomy), with a hospital mortality of 25 per cent.

5. Three patients are surviving 2.5 to 5.5 years after successful resection. All had squamous cell carcinoma. They are now clinically well.

6. One patient survives and is working 3.5 years after radiation therapy.

7. Radiation therapy increased the average life expectancy from 5.0 months in the untreated group to 8.6 months in the group which was treated by radiation, with or without surgical exploration. This difference of 3.6 months does not have statistical significance.

DISCUSSION.—DR. EVARTS A. GRAHAM, St. Louis, Mo.: I am glad that Doctor Lindskog has reported his results. It is desirable that everyone who is having experience with bronchiogenic carcinoma should present his results because it is still necessary to indulge in a campaign of education of the medical profession about this disease. I do not share the pessimism which some others have. The only aspect that I am pessimistic about is the fact that in most cases the condition is not recognized early enough to do something for the patient. The fault is partly the patient's own, because he neglects to see his doctor. I am sorry to say, however, that the larger fault is with the medical profession who fail too often even to think of the possibility of the condition.

In the last three years (1943, 1944, 1945) 221 patients have been admitted to the Barnes Hospital with bronchiogenic carcinoma. Of this number, 109 patients (49 per cent) were considered inoperable on the basis of the clinical examination. Although 112 were subjected to exploratory operation, in only 39 cases (18 per cent) was it possible to remove the lung with a reasonable chance of curing the patient. These figures show

why it seems necessary to educate both the public and the medical profession in the early signs and symptoms. The diagnosis in most cases is easy. In our experience a positive bronchoscopic diagnosis can be made in about 70 per cent of the cases. Even in the others the clinical and roentgenographic evidence is sufficiently characteristic to make the diagnosis almost certain.

There is certainly too much pessimism about the end-results of operation for bronchiogenic carcinoma. Although cancer is always a serious disease and the sudden removal of an entire lung is necessarily a severe physiologic jolt to one whose cardiovascular system is not entirely normal, nevertheless the results of the operation are very encouraging. The first patient who had a successful total pneumonectomy for this condition is alive and well 13 years later. I have six patients who are alive and well more than seven years after operation. I think if patients can be obtained in larger numbers in an operable stage it will be possible in another decade for someone to report before this Association 50 to 60 per cent of five-year cures.

DR. ALTON OCHSNER, New Orleans, La.: I would like to emphasize a point referred to by Doctor Lindskog, that is the necessity for operating upon more of these people. I was astounded by the statements of Doctor Graham and Doctor Lindskog that so few are operable. We have had 267 primary carcinomas in which we were able to do a resection in 103 cases, an incidence of 34.4 per cent; 28 per cent were refused operation and one refused operation. I feel that inoperability means metastases. I think palliative resection is justifiable. Of 166 operated upon, 103 were resected (62 per cent). Not all are well by any means, but I think we are justified in doing palliative resection if we can do it safely. I have one patient alive five years after resection of a tumor which had invaded the mediastinum, in which there was recurrent nerve paralysis. I am sure he is going to die and I am sure he has cancer, but he is free from pain. So I would like to make a plea for resection for palliative reasons.

DR. CARL EGGERS, New York City: I would like to add a small list to this imposing group. I am not giving the total number of cases seen, which is large, but we have explored 35 patients. We performed lobectomy in one and complete pneumonectomy in 15. I agree with Doctor Ochsner that one should not hesitate to explore, because some cases that look discouraging may turn out to be operable. The results in our cases are as follows: Eight patients have died since removal of the tumor, two or three postoperatively, the others anywhere from a few weeks to two and one-half years later, all of recurrence; seven patients are living, one seven years, one four years, one three years, one two years, and the other three cases something over a year. The interesting thing is that the patient living longest is one who had lymph node involvement. This indicates that in cancer of the lung one has to use the same radical procedure as in cancer of other organs. All these patients who are living have returned to their usual occupation—work or golf—and apparently are entirely well.

I should like to show some slides which illustrate the rate of growth of some lung cancers and also stress the importance of paying attention to small tumors. The first patient had a routine chest examination made at the medical department of one of the life insurance companies. A little shadow was found in the upper lung. Bronchoscopy was advised but refused because of the absence of symptoms. The next year, on examination, the tumor had somewhat enlarged, but bronchoscopy was again refused. Later in the year the patient began to have symptoms, and roentgenograms showed the tumor still larger. When seen at the hospital, a planogram showed not only the tumor but also a large lymph node in the hilum. A pneumonectomy was performed and the patient recovered and returned to her work. About two years later she developed metastasis and succumbed. Had she been operated upon earlier she might have been cured.

The second case is the relative of a physician who was visiting in his home. During conversation he heard her wheezing, whereupon he took a roentgenogram of the chest and found atelectasis of one lung. An interesting feature of this case is that on looking over a roentgenogram taken four years before, a shadow is visible at the site of the present atelectasis. A diagnosis of carcinoma was made and she had a pneumonectomy performed, with recovery. There is reason to believe that this is one of the slow-growing carcinomas which took four years to reach a size blocking the bronchus. It should offer a favorable prognosis.

DR. GUSTAF E. LINDSKOG, New Haven, Conn. (closing): I wish to thank Doctor Graham, Doctor Ochsner and Doctor Eggers for their comments. I did not mean to leave a note of complete pessimism, but I do want to emphasize that our series is typical of the case material we are up against in general hospitals at the present time; even though in the state of Connecticut, I believe, we have a good educational program against cancer. While I was in the Service another surgeon had charge of our chest service, and we know his figures are not going to vary greatly from this series.

I also have operated upon a group which might be considered palliative. Ten of the 12 resections were complicated pathologically. One case surviving five and a half years had an involvement of the pleura locally by extension of the tumor. A second case had an empyema of pneumococcal type complicating obstruction by the tumor, and this patient was operated upon in a single stage, with primary closure. The third living patient had no complications.

In the roentgen ray treatment group only one patient is living with the disease, at three and a half years. The proper management of this disease depends in part on education of the public, but also on education of the practitioner, who must be made responsible for initiating the diagnostic program.

PALLIATIVE GASTRECTOMY IN SELECTED CASES OF GASTRIC ULCER*

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CHRONIC BENIGN ULCERS high on the lesser curvature of the stomach and those juxta-esophageal in position have always presented technical problems in their surgical management. A multiplicity of procedures has been advocated. At first, these operations were designed to relieve the gastric retention secondary to a reflex pylorospasm. However, gastrojejunostomy, usually without the local excision of the lesion, even though it relieves the obstruction, has been found to be an unreliable and ineffectual operation in most of these cases of gastric ulcer and occasionally a gastrojejunal ulcer develops. Gastro-enterostomy produces no permanent reduction in the degree of gastric acidity which evidently is more fundamental in the pathogenesis of ulcer than is the correction of motor disturbances. Pyloroplasties of various types which aim to eliminate the reflex spasm of the pyloric canal rarely effect a permanent healing of these high gastric lesions. A sleeve resection in this type of case is not only impractical but also fails to correct one of the basic factors responsible for the production of ulcer. Jejunostomy for ailmentation as a definitive procedure in gastric ulceration has been discarded. It still is indicated as a preliminary procedure[1] in those cases in which a massive ulceration adherent to neighboring organs precludes immediate gastric resection. At present, most surgeons have unequivocally accepted subtotal gastrectomy as the operation of choice in gastric ulcer. Not only is the ulcer-bearing area removed for careful histologic examination, but the resection of the pylorus and antrum eliminates the chemical phase of gastric secretion and causes an appreciable reduction in the acidity. Follow-up examinations of patients upon whom a subtotal gastrectomy has been performed for gastric ulcer have revealed uniformly satisfactory results. Chemical analysis of test meals in these patients have shown an achlorhydria in well over 95 per cent of these cases, and when a subtotal gastrectomy is performed for lesions at or above the reëntrant angle of the stomach in which not only the pylorus and antrum are resected but part of the fundus as well, an achlorhydria results in practically 100 per cent of the cases.[2] In the absence of gastric acidity, gastric and gastrojejunal ulcers apparently do not develop, and it is mainly for this reason that the operation of subtotal gastrectomy for gastric ulcer has been so incontrovertibly established. Unfortunately, however, a radical removal of juxta-esophageal lesions would entail a complete

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gastrectomy, an operation attended primarily by a high mortality rate, and, if the patient survives, by nutritional difficulties of a permanent nature. It is true that innumerable modifications embodying the principle of gastric resection have been done for ulcers high on the lesser curvature. The history and description of these various procedures have been excellently reviewed and thoroughly discussed.[3] These operations have as their goal the removal of the ulcer-bearing lesser curvature, leaving a patent esophagus and enough of the fundus to effect a gastro-enteric anastomosis, but, at best, they are technically difficult even in the hands of experts. What would be the result, then, if in these high-lying gastric lesions, presumably benign by all available clinical and laboratory criteria, an adequate subtotal gastrectomy could be performed below the lesion, leaving the ulcer *in situ? A priori,* an achlorhydria should result. Clinical experience has shown this to be true and has demonstrated that these ulcers not only heal in an anacid stomach, but do not recur.

Madelener,[4] in 1923, reported the first successful cases of high-lying gastric ulcers which completely disappeared following a simple pylorectomy followed by a Billroth-I anastomosis. Florcken[5] subsequently performed a subtotal gastrectomy of the Billroth-II type, distal to the ulcer, which he did not remove, and called the procedure "palliative gastric resection." Since then numerous European surgeons have reported their experiences with this procedure.[3] It must be stressed that it is applicable only in those cases in which the ulcer occupies the upper third of the stomach so that approximately one-half to two-thirds of the stomach distal to the lesion may be resected. This will naturally restrict the field of "palliative gastric resection" to (1) juxta-esophageal ulcers and peptic ulcers of the esophagus; (2) high lesser curvature ulcers; and (3) these penetrating ulcers situated on the posterior wall of the cardia in which the general physical condition of the patient does not warrant the operative trauma of a subtotal gastrectomy with the removal of the ulcer.

The operation is best performed under spinal anesthesia. The usual mid-epigastric incision is made from the ensiform cartilage to the umbilicus. The stomach is then carefully examined to determine the extent and nature of the lesion. The gastric lymph nodes and liver are palpated for evidences of metastases. If there is doubt as to the benign nature of the ulcer, the lesion may be visualized through a gastrotomy and, if necessary, a specimen removed for immediate pathologic examination.

The technic of palliative gastrectomy is similar to that employed for a retrograde subtotal gastrectomy. The right gastric vessels are ligated distal to the pylorus, and, at a point opposite, close to their origin, the right gastro-epiploic vessels are divided. The duodenum is then sectioned just distal to the pylorus, closed in layers, and buried against the head of the pancreas. The pyloric end of the stomach is reflected to the left and the gastrocolic omentum is divided. This gives an excellent exposure of the lesser omental sac, and any attachments of the posterior wall of the stomach to the pancreas.

The left gastro-epiploic vessels are divided at the point of proposed resection, and the left gastric artery is ligated distal to the ulcer. After this mobilization, one may determine whether it is more expedient to include the ulcer in the resection or simply perform a palliative gastrectomy. A DePetz clamp is then applied and the resection completed. Gastro-intestinal continuity is restored by an isoperistaltic terminolateral gastrojejunostomy of the Hofmeister type, made anterior to the colon. The abdominal incision is closed with interrupted buried steel wire.

It is granted that certain complications may follow a gastric ulcer which has been left *in situ*. In our experience, and those of others, these are fortunately rare.[3] It has been stated that the reduction of acidity decreases its bacteriocidal effect and that the infection ordinarily present in these callous ulcers may increase. Occasionally a profuse diarrhea, probably due to an enteritis secondary to a gastric anacidity may occur. Bleeding and perforation of the ulcer have been reported. Cicatrices incident to the healing of these high ulcers have caused esophageal stenoses but these yield to dilatation. Subsequent malignant degeneration of a previously benign ulcer is exceedingly rare, but one may diagnose a lesion as benign when in reality it is malignant. However, the results of a total gastric resection for a penetrating carcinomatous ulcer of the cardia are so poor that the error of performing a total gastrectomy for benign ulcer is decidedly worse than that of performing a palliative gastrectomy for a high-lying malignant ulcer.

During the past seven years subtotal gastrectomy was the only operative procedure employed in 53 consecutive ward patients suffering from gastric ulcer.[6] In eight of these cases a palliative gastrectomy was performed. This group consisted of patients over 50 years of age, and in poor general condition. Some had been recalcitrant to repeated courses of medical treatment. Others were suspected preoperatively of having malignant disease of the stomach and were explored soon after admission. Seven patients had normal or elevated free and combined acid figures in the Rehfuss test meal; low acid figures were obtained in one patient.

There was one postoperative death which occurred within 24 hours, and was apparently due to an acute coronary thrombosis.

The patients were personally interviewed and examined at frequent intervals in our Follow-up Clinic for periods ranging from 21 months to eight years (Table I). All have been relieved of gastric symptoms and have gained weight. Rehfuss test meals (specimens taken every 15 minutes during a two-hour period) disclosed the complete absence of free hydrochloric acid in every specimen. Most patients have had these tests repeated, with similar results. Repeated roentgenographic and gastroscopic studies have failed to disclose any pathology, except in Case 8, in which there was evidence of fibrous narrowing at the ulcer site (Fig. 3B). This patient died 21 months after operation from uremia and pneumonia; and autopsy disclosed a completely healed gastric ulcer.

It seems logical to assume that in selected cases of high-lying chronic

gastric ulcers, palliative gastrectomy produces a permanent gastric achlorhydria, with subsequent healing and disappearance of the ulcer which was left *in situ*. These patients have remained clinically free of symptoms, and gastroscopic and roentgenologic examination have failed to reveal any recurrence of either a gastric or a gastrojejunal ulcer. This operation has its place in the surgery of peptic ulcer and is indicated in benign lesions limited to the upper third of the stomach.

CASE REPORTS

CASE 1.—H. Z., (No. 416481), a 55-year-old blacksmith, was readmitted, November 10, 1937, complaining of pain in the upper abdomen. He had originally been admitted to the hospital in January, 1937, at which time he gave a six-month history of epigastric pain partially relieved by food, weakness, and the loss of ten pounds in weight. The remainder of the history was noncontributory. Examination had been essentially negative. Roentgenologic examination had disclosed a penetrating ulcer on the lesser curvature well above the reëntrant angle. The patient had been treated medically, and after three and one-half weeks was asymptomatic and was discharged. The lesion had grown distinctly smaller, as seen roentgenographically. The patient was well for about a month, after which the pains recurred. During the month before readmission his symptoms had increased in severity, and food and medication no longer produced relief. He returned to the hospital for surgical therapy.

TABLE I

Case No.	Age	Size in Cm. of Resected Specimen: Lesser Curvature	Size in Cm. of Resected Specimen: Greater Curvature	Preop. Acidity: Free	Preop. Acidity: Comb.	Postop. Acidity: Free	Postop. Acidity: Comb.	Follow-up Years and Months
1	55	14	16	62	74	0	34	7 years, 0 months
2	50	11	17	40	68	0	8	8 years, 3 months
3	58	9	14	70	84			Ceased 1 day, p.o.
4	54	8	17	55	80	0	14	6 years, 7 months
5	61	7	19	65	90	0	30	5 years, 4 months
6	53	8	21	2	15	0	20	5 years, 2 months
7	54	3	19	20	55	0	10	2 years, 3 months
8	80	8	20	30	55	0	16	1 year, 9 months

Examination disclosed an elderly male in moderately severe pain. His oral hygiene was extremely poor. Examination of the chest disclosed evidences of chronic bronchitis and emphysema. The heart sounds were distant. There was a faint systolic murmur at the apex. There was moderate peripheral arteriosclerosis. Blood pressure 160/90. The upper abdomen was tender. The liver edge was palpable 3 cm. below the costal margin. There was a left inguinal hernia present. The hemoglobin was 98 per cent. Blood chemistries were reported—urea 17 mg. per cent, sugar 100 mg. per cent, chlorides 450 mg. per cent, and CO_2 combining power 56.5 vol. per cent. Urine was negative. The Rehfuss test meal disclosed a free acid of 62, and a combined acid of 74 millimoles per cent.

It was felt that this patient was suffering from a deeply penetrating ulcer which was not responding satisfactorily to medical therapy, or possibly from an ulcerating

carcinoma. He had had an adequate trial of medical therapy both in the hospital and at home, with unsatisfactory results.

Accordingly, on November 13, 1937, the patient was explored under avertin-ethylene anesthesia. High up on the lesser curvature and posterior wall of the stomach was a hard indurated mass which invaded and was attached to the pancreas. The lesion was red and edematous and extended downward from the esophagus to about the reëntrant angle of the stomach. In the region of the duodenum there was evidence of an old ulcer with adhesions of the gallbladder to the first portion of the duodenum. A typical palliative gastrectomy was performed and gastro-intestinal continuity was restored with a posterior gastrojejunostomy of the Hofmeister type. The duodenum and surface of the gallbladder were drained through a stab wound.

Pathology.—The resected specimen measured 14 cm. along the lesser curvature and 16 cm. along the greater curvature. There was evidence of chronic gastritis.

Postoperatively, the patient developed a moderately severe bronchopneumonia and a peri-anal abscess. His wound healed well. No ulcer could be found roentgenographically on December 6, 1937, 23 days after operation. Test meal studies, done on November 30, 1937, disclosed no free acid and a combined acidity of 34 millimoles per cent. Another test meal, December 2, 1937, also disclosed no free acid. He was discharged on December 9, 1937, his 26th postoperative day.

The patient has been seen frequently in the Follow-up Clinic. He continued to feel well and had no gastric complaints whatsoever. Gastroscopy in January, 1938, had disclosed a complete disappearance of the lesion. He was last seen in the Follow-up Clinic on March 22, 1944, at which time he was completely free from gastro-intestinal symptoms. When he was next sent for, a letter was received from his wife stating that he had been well until November 15, 1944, when he had suddenly been taken with severe headache, fever, rapidly ensuing quadriplegia and death. A letter received from Morrisania Hospital, where he died, stated that the cause of death was probably a cerebral accident. No postmortem examination was performed.

Case 2.—No. 415549: J. S., a 50-year-old male, was admitted, October 18, 1937, complaining of abdominal pain of six months duration. The pain had been growing progressively more severe and more frequent. Occasionally food relieved his pain for a few minutes. The patient had lost 20 pounds in weight during this time and had experienced a pronounced loss of appetite during the preceding two months. Several tarry stools had been noticed in the two weeks preceding entry to the hospital. During the five days prior to admission he had vomited repeatedly and had noticed amelioration of his pain after the emesis. Past history was essentially noncontributory except for the fact that the patient had noticed dyspnea and precordial pain on exertion.

Physical examination disclosed a thin, middle aged male who appeared to have lost considerable weight. The heart and lungs were essentially normal. There was moderate peripheral sclerosis. The blood pressure was 142/90. There was definite upper abdominal tenderness, but no spasms or masses were palpated. The weight was 113 pounds. The urine was negative. Hemoglobin was 90 per cent; the white blood count was 11,500, with an essentially normal differential count. The blood chemistries were reported: urea 20 mg. per cent, sugar 140 mg. per cent. The Wassermann was negative. The Rehfuss test meal disclosed a free acidity of 40 and a combined acidity of 68 millimoles per cent. No occult blood was found in the stool.

Gastro-intestinal roentgenograms disclosed a perforating lesion on the posterior wall near the lesser curvature in the region of the reëntrant angle. The lesion was 1.5 inches in diameter. The duodenal bulb showed a persistent deformity on the greater curvature side.

Gastroscopy disclosed a circular, sharply outlined ulcer on the lesser curvature and posterior wall of the stomach. It had the appearance of a benign ulcer.

The patient was treated medically for three weeks after which roentgenographic examination disclosed the gastric lesion to have diminished in size. Clinically, however, the patient evidenced no improvement, and in view of the persistent pain which had yielded slightly, if at all, to diet and medication, it was felt that operation was indicated.

The patient was explored, November 19, 1937, under avertin-ethylene anesthesia. The stomach was normal in size. Above the reëntrant angle was a definite gastric ulcer infiltrating the body of the pancreas. The duodenum was normal. Because of the high position of the ulcer, and its infiltration into the pancreas, it was decided that a palliative gastrectomy should be done. Accordingly, a typical palliative gastrectomy, leaving the gastric ulcer *in situ,* was performed. Gastro-intestinal continuity was restored by a retrocolic gastrojejunostomy of the Hofmeister type.

Pathology.—The resected specimen measured 11 cm. along the lesser curvature and 17 cm. along the greater curvature. The mucous membranes showed evidence of chronic gastritis.

Postoperatively, the patient developed a bronchopneumonia and temperature as high as 103.6° F. This subsided quite rapidly, however, and the patient was making a satisfactory convalescence when, on the eighth day, shortly after the through-and-through sutures had been mistakenly removed, the patient suffered a wound separation during a paroxysm of coughing. The liver appeared in the wound. This was packed back with iodoform gauze and strapped across. No further complications ensued, and the patient was discharged on the 24th postoperative day.

The patient was seen frequently in the Follow-up Clinic. He was completely asymptomatic, had gained 22 pounds, and never suffered pain, vomiting, or bleeding. The last gastroscopy was performed on January 29, 1945, at which time the residual stomach was found to be completely normal. There was no evidence of the previous ulcer. He had been repeatedly roentgen-rayed but no ulcer had ever been found. His last roentgenologic examination was performed on January 19, 1945. No evidence of ulcer was seen. Test meals had been done on many occasions and had failed to show any free acid. On July 2, 1945, a test meal revealed no free acid, and a combined acid of 8 millimoles per cent. On March 6, 1946, another test meal showed no free acid and a combined acid of 10 millimoles per cent. The patient was last seen on March 6, 1946, and was in excellent health.

CASE 3.—No. 416478: J. G., a 58-year-old male, was readmitted, November 10, 1937, complaining of abdominal pain of one year's duration. He had been treated in the hospital five months previously for a known gastric ulcer. He improved with medical therapy and was discharged. However, he continued to lose weight and strength, the pain recurred and became progressively more severe, and vomiting occurred with increasing frequency.

Physical examination disclosed a slight, chronically ill male, showing evidences of recent weight loss. The heart and lungs were essentially negative. There was marked peripheral sclerosis. The blood pressure was 140/78. There was slight tenderness in the epigastrium. He weighed 85 pounds. The urine was negative. The hemoglobin was 83 per cent, the white blood count 11,200, the differential was normal. The blood urea nitrogen was 17 mg. per cent. The Wassermann test was negative. The Rehfuss test meal showed a free acid of 70 and a combined acid of 84 millimoles. The stool did not contain occult blood.

Gastro-intestinal roentgenograms showed a penetrating gastric ulcer about one inch in diameter on the posterior wall near the lesser curvature, just below the level of the cardia.

Gastroscopy disclosed a punched-out ulcer high on the lesser curvature. The electrocardiogram disclosed occasional auricular extrasystoles, high P waves, QRS low in I, high in II. This configuration is seen in an asthenic type of heart.

The patient was treated medically but his pain continued and it was finally felt that surgical intervention was imperative.

At operation, an ulcer about two inches in diameter was found on the lesser curvature just below the esophagus, penetrating into the pancreas. There was evidence of a healed duodenal ulcer. It was felt that removal of the gastric ulcer would entail a total gastrectomy, which was not indicated. Accordingly, a palliative partial gastrectomy was performed, leaving the ulcer *in situ*. Gastro-intestinal continuity was restored by a retrocolic isoperistaltic gastrojejunostomy of the Hofmeister type.

Pathology.—The resected specimen measured 9 cm. along the lesser curvature and 14 cm. along the greater curvature. The microscopic examination disclosed chronic gastritis.

The first postoperative morning the temperature was 100° F.; pulse 100; the tongue moist; the abdomen soft. Later that day, however, the patient suddenly developed acute pulmonary edema, together with marked shock. The pulse rose to 190, and the blood pressure fell to 64/40. The patient exhibited no evidences of bleeding. He was placed in an oxygen tent, a phlebotomy performed, 50 per cent glucose was administered intravenously, morphine and atropine given by hypodermic injection. Despite energetic therapy, the patient ceased two hours after the onset of the attack. The medical consultant who saw the patient felt that the incident represented an acute coronary artery thrombosis with left ventricular failure.

A postmortem examination could not be obtained.

CASE 4.—No. 436884: H. R., a 54-year-old male, was readmitted, February 28, 1939, complaining of abdominal pain and vomiting. His original admission to the hospital had been on December 27, 1937, at which time he gave a history of having suffered from attacks of severe abdominal pain, partially relieved by food or soda, during the past ten years. Physical examination had disclosed epigastric tenderness and an epigastric hernia. Roentgenograms had revealed a large penetrating gastric ulcer well above the reëntrant angle, and a deformed duodenal bulb. Gastroscopically, the lesion was suspicious of malignancy. The patient's symptoms regressed and the size of the ulcer diminished after three weeks of conservative ulcer therapy. Despite this, operation was advised, because of the still present suspicion of malignant disease. The patient, however, refused permission for operation, and left the hospital. He was followed in the Out-patient Department and was gastroscoped again one year later (January 30, 1939). The picture was essentially unchanged. He returned to the hospital, February 28, 1939, because of continued pain, unrelieved now by food or alkalies, anorexia, heart burn, loss of 12 pounds, and occasional vomiting.

Physical examination revealed a thin, chronically ill male. The heart and lungs were essentially normal. Blood pressure 120/75. There was slight epigastric tenderness and an easily reducible epigastric hernia. Weight 122 pounds. Urine was negative. The hemoglobin was 73 per cent, the white blood count 11,000, with a normal differential count. The blood urea was 19 mg. per cent. The Wassermann test was negative. The Rehfuss test meal showed a free acid of 55 millimoles per cent and a total acidity of 80 millimoles per cent. Examination of the stool revealed no occult blood.

Gastro-intestinal roentgenograms revealed a gastric ulcer well above the reëntrant angle. The penetration seen on previous roentgenologic examination was no longer present. The duodenal bulb was deformed.

Gastroscopy visualized a large gastric ulcer on the posterior wall adjacent to the lesser curvature, extending half way to the greater curvature. The gastroscopist again reported the lesion to be very suspicious of neoplastic disease.

Exploratory celiotomy was performed on March 18, 1939, under general inhalation anesthesia, through a midepigastric incision. There was an acutely inflamed, and very edematous lesion on the posterior wall of the stomach, well above the reëntrant angle. It was infiltrating into, and adherent to, the pancreas. There was a scar on the anterior wall of the duodenum. The stomach was opened and the ulcer palpated from within. The actual ulceration was about 1.5 inches in diameter, but the induration and inflammation was about four to five inches in size. There were many surrounding nodes.

a few of which were removed for examination. A typical palliative gastrectomy was performed. The gastric ulcer was left *in situ*. Gastro-intestinal continuity was restored by means of an antecolic gastrojejunostomy of the Hofmeister type.

Pathology.—The resected specimen measured 8 cm. along the lesser curvature and 17 cm. along the greater curvature. (The specimen was apparently poorly preserved and had shrunken considerably.) Microscopic examination revealed chronic gastritis. The lymph nodes contained no malignant cells.

The postoperative convalescence was complicated by a gastric atony which gradually cleared up. He was discharged on the 16th postoperative day. A Rehfuss test meal performed on this day revealed no free acid; the combined acid measured 33 millimoles per cent.

The patient has been seen frequently in the hospital and in the Follow-up Clinic. Six weeks after discharge he developed an abscess on his larynx which required a tracheotomy and incision and drainage. In January, 1944, an appendicectomy was performed for acute gangrenous appendicitis. He was again admitted in February, 1944, for treatment of arteriosclerotic cardiovascular disease.

The patient has been free from gastric symptoms. He has gained about ten pounds and has been working.

He has been roentgen-rayed repeatedly, but no sign of the ulcer has ever been found. He was last examined roentgenologically on May 23, 1945, at which time no pathologic findings were noted.

Rehfuss test meal performed on January 29, 1945, again showed no free acid. Combined acids measured 14 millimoles per cent.

The patient was gastroscoped on October 29, 1945. No evidence of gastric or gastrojejunal ulceration was seen. There was observed a depressed scar of the healed gastric ulcer.

CASE 5.—No. 463475: M. T., a 61-year-old male, was admitted, October 5, 1940, complaining of intermittent epigastric pain, of one and one-half years duration. The pain had at first been mild and had been relieved by a hot water bag. Ingestion of food had given no relief, The pain had increased in severity and frequency, and had been more recently accompanied by radiation of the pain to the lower back, vomiting, and a loss of six pounds in weight. The past history was noncontributory.

Physical examination disclosed an emaciated male who appeared to have lost more than the admitted six pounds. There were numerous rhonchi throughout both lungs. Moderate peripheral sclerosis was present. Blood pressure 98/70. A somewhat irregular liver edge was palpable 2.5 inches below the costal margin. No masses or tenderness were present. The patient weighed 94 pounds. The urine was negative. The hemoglobin was 81 per cent; the white blood count was 11,500, and the differential count was normal. The blood chemistries were reported: urea 15 mg. per cent, chlorides 585 mg. per cent, CO_2 combining power 64.3 vol. per cent. The Wassermann was negative. The Rehfuss test meal disclosed a free acid of 65 and combined acids of 90 millimoles per cent. Repeated stool examinations failed to disclose occult blood. The electrocardiogram disclosed changes suggesting myocardial disease.

Gastro-intestinal roentgenograms (Fig. 1A) revealed a wide deep incisure on the greater curvature extending to the lesser. A small pocket, which is probably an ulcer, was seen on the lesser curvature above the incisure. The duodenal bulb was deformed.

Gastroscopy visualized a large ulcer on the anterior wall and lesser curvature above the incisura. It had a grayish, nodular base and the margins were undermined. The lesion was suspicious of a malignant ulceration.

The patient was explored, November 14, 1940, under cyclopropane anesthesia. A gastric ulcer was found high on the lesser curvature, near the esophagus. The lesion was somewhat posterior, and its crater extended into the pancreas. In the first portion of the duodenum was the scar of a healed duodenal ulceration. A typical palliative partial gastrectomy was performed, the gastric ulcer being left *in situ*, and

gastro-intestinal continuity was restored by means of a retrocolic gastrojejunostomy of the Hofmeister type. The closed duodenum was drained through a right subcostal stab incision, because of the friability of the tissues.

Pathology.—The resected specimen measured 7 cm. on the lesser curvature and 19 cm. on the greater curvature. The microscopic examination disclosed chronic and acute gastritis.

Postoperatively, the patient developed a profuse duodenal leak on the sixth day, but this diminished rapidly in amount, and the drainage stopped shortly after removal of

FIG. 1-A

FIG. 1-B

FIG. 1-A.—Case 5: Roentgenogram of high lesser curvature ulcer.
FIG. 1-B.—Case 5: Roentgenogram of stomach 4.5 years after palliative gastrectomy.

the duodenal drain on the 11th postoperative day. He was discharged on the 18th postoperative day.

The patient has been seen repeatedly in the Follow-up Clinic. He gained 20 pounds in weight, and had no complaints. Test meals, on June 29, 1941 and July 2, 1945, disclosed no free acid, combined acids of 30 millimoles per cent maximum.

Gastroscopy, April 3, 1945, disclosed no evidence of ulcer. There was no atrophic gastritis present. Roentgenologic examination of the stomach was performed on April 11, 1945 (Fig. 1B). No evidence of ulcer disease was found.

The patient was last seen in the Follow-up Clinic, March 9, 1946, at which time he was in excellent health.

CASE 6.—No. 466833: I. A., a 53-year-old male, was readmitted, December 21, 1940, complaining of abdominal pain and dysphagia. His original admission to the hospital had been on January 14, 1939, at which time he had suffered from abdominal pain for six years. Exploratory celiotomy had disclosed a perforation of the gallbladder into a well walled-off indurated mass. The gallbladder was chronically inflamed and contained two stones. Cholecystectomy was performed, and the patient made an uneventful recovery. He had been well until a year before his next admission when he began to suffer from attacks of upper abdominal pain unrelated to, and unrelieved by food. The attacks often occurred at night, awakening him from sleep and, more recently, the

pain had been radiating through to the back. Marked constipation had been present. He had suffered no weight loss. For four weeks he had been having difficulty swallowing solid food and often the food would seem to "stick in his throat," and would be subsequently regurgitated. The past history was noncontributory.

Physical examination disclosed an elderly, well-developed male. The heart and lungs were essentially normal. Blood pressure 130/90. There was a well-healed right upper rectus incision. No abdominal masses or tenderness were present. The weight was 120 pounds. The urine was negative. The hemoglobin was 98 per cent;

FIG. 2-A

FIG. 2-B

FIG. 2-A.—Case 7: Roentgenogram of high lesser curvature ulcer.
FIG. 2-B.—Case 7: Roentgenogram of stomach one year after palliative gastrectomy.

FIG. 3-A

FIG. 3-B

FIG. 3-A.—Case 8: Roentgenogram of high lesser curvature ulcer.
FIG. 3-B.—Case 8: Roentgenogram of stomach one year after palliative gastrectomy.

white blood count 7,900, with a normal differential count. Blood urea was 30 mg. per cent. The Wassermann was negative. The Rehfuss test meal disclosed a perceptible amount of free acid to be present. The combined acidity was 15 millimoles per cent.

Gastro-intestinal roentgenograms disclosed a large neoplasm involving the cardiac end of the stomach. There was a 25 per cent residue at the six-hour observation.

Esophagoscopy disclosed some thickening and rigidity of the cardia. A biopsy of the terminal esophageal mucous membrane was reported "esophageal mucosa without significant change." Gastroscopy was not performed.

The patient was explored, January 10, 1941, under continuous spinal anesthesia augmented by sodium pentothal intravenously. Numerous adhesions were dissected free. A juxta-esophageal gastric ulcer penetrating into the liver and pancreas was found. Because of the extremely high location of the ulcer a typical palliative gastrectomy was performed leaving the gastric ulcer *in situ*. Gastro-intestinal continuity was restored by an antecolic gastrojejunostomy of the Hofmeister type.

Postoperatively, the patient experienced an uneventful convalescence. The wound healed by primary union. A Rehfuss test meal, 21 days after operation, revealed no free acid.

Pathology.—The resected specimen measured 8 cm. along the lesser curvature and 21 cm. along the greater curvature. The mucous membrane showed evidence of chronic gastritis with multiple healed erosions.

The patient was seen frequently in the Follow-up Clinic and in the Gastro-intestinal Clinic. At first he had had occasional cramps after eating but this eventually disappeared. A Rehfuss test meal, June 20, 1941, showed no free acid present, maximum combined acidity was 20 millimoles per cent. The patient was last seen in the Follow-up Clinic, March 21, 1946, at which time he looked and felt well, and had no pain, no vomiting, no bleeding and no dysphagia. Roentgenologic examination, April 14, 1945, had disclosed no ulcer; the rugae were unusually prominent. Gastroscopy, April 7, 1945, had revealed no erosions or ulceration, and no evidence of the previous ulceration.

CASE 7.—No. 513023: H. H., a 54-year-old male, was admitted, November 12, 1943, complaining of epigastric pain and burning of three years' duration. The pain had been subject to exacerbations and remissions and was usually relieved by the ingestion of food. He had been treated in the Out-patient Department with diet and medication. Two weeks before admission the pain had become more severe, had radiated through the abdomen to the back, and the patient was advised to enter the hospital. The past history was noncontributory.

Physical examination was essentially negative. The urine was normal. The hemoglobin was 92 per cent, the white blood count normal. The blood chemistries were reported: urea 20 mg. per cent, chlorides 575, CO_2 72 vol. per cent. The Wassermann was negative. The Rehfuss test meal revealed a free acid of 20, total acid of 55 millimoles per cent.

Gastro-intestinal roentgenograms (Fig. 2A) disclosed a penetrating gastric ulcer ¾-inch in diameter, high up on the posterior wall and lesser curvature of the stomach.

Gastroscopy disclosed a gastric ulcer 3 cm. in diameter located on the posterior wall and lesser curvature, located about 3 cm. from the esophagus.

The patient was explored, November 15, 1943, under continuous spinal anesthesia. Juxta-esophageally was a penetrating gastric ulcer attached to the pancreas and causing a great deal of induration and edema of the stomach wall. There were many surrounding lymph nodes, two of which were removed for biopsy. A typical palliative partial gastrectomy was performed, the ulcer being left *in situ*, and gastro-intestinal continuity was restored by an anterior terminolateral gastrojejunostomy of the Hofmeister type.

Pathology.—The resected specimen measured 4 cm. along the lesser curvature and 19 cm. along the greater curvature. The microscopic report of the stomach and nodes was unfortunately lost.

The patient had an entirely uneventful postoperative convalescence and was discharged on the 14th day.

The patient has been seen repeatedly in the Follow-up Clinic. He has remained symptom-free and has gained weight and strength. Roentgenograms of the stomach, January 15, 1945 (Fig. 2B), disclosed no ulcer. Gastroscopy was performed on January 31, 1945, and disclosed merely a depressed scar of the previous ulceration. Rehfuss test meal was done on January 10, 1945. There was no free acid; total acidity measured 18 millimoles per cent. The test meal was repeated, February 27, 1941, and revealed no free acid; combined acidity of 10 millimoles per cent. He was last seen in the Follow-up Clinic, February 20, 1946, and was in excellent health.

CASE 8.—No. 515771: R. K., a 60-year-old female was admitted, January 24, 1944, complaining of loss of appetite during the past two years and a 60 pound weight loss in the past six months. She reported no pain or vomiting. On repeated questioning, however, she admitted to some upper abdominal distress after meals. The past history was essentially noncontributory.

Physical examination disclosed an emaciated chronically ill female. The heart and lungs were negative. The blood pressure was 184/90. The abdomen was soft, nontender, and no masses were palpable. The patient's weight was 81 pounds.

The urine was negative. Hemoglobin was 52 per cent, red blood count 3,490,000; white blood count 15,450, with a normal differential count. The blood chemistries were reported: urea 10 mg. per cent, sugar 85 mg. per cent, chlorides 450 mg. per cent, the CO_2 combining power 59.2 vol. per cent, total proteins 7.3 grams per cent. Blood Wassermann negative. The stool examination for occult blood was markedly positive on more than one occasion. The Rehfuss test meal revealed a free acid of 30 and total acids of 55 millimoles per cent.

Gastro-intestinal roentgenograms (Fig. 3A) revealed a large penetrating ulcer on the lesser curvature and posterior wall of the stomach about two inches below the cardia. The crater was about two inches in diameter. There was considerable displacement of the mucosal pattern, which might have been due to malignancy or an inflammatory mass. There was a 25 per cent residue at the end of six hours.

Gastroscopy disclosed a large polypoid tumor involving the posterior wall and presenting an ulcer about 4 cm. wide at its summit. The proximal edge appeared to be about 5 cm. below the esophagus. The impression was polypoid carcinoma with atrophy of the mucosa.

The patient was thought to have a neoplasm of the stomach and was prepared for operation with repeated transfusions, intravenous fluids, parenteral vitamins and daily gastric lavages.

Exploratory celiotomy was performed, February 10, 1944, under spinal anesthesia, supplemented later with general inhalation anesthesia. The upper portion of the lesser curvature was greatly thickened and inflamed and was markedly adherent to the liver and pancreas. The lesion appeared to be an inflammatory process. The stomach was opened and the lesion was palpated from within. Just below the esophagus, on the lesser curvature, was a punched-out ulcer one inch in diameter. A typical palliative partial gastrectomy was performed, the ulcer being left *in situ*. A terminolateral antecolic gastrojejunostomy of the Hofmeister type was performed to restore gastro-intestinal continuity. A jejunostomy for alimentation was instituted.

Pathology.—The resected specimen measured 8 cm. along the lesser curvature and 20 cm. along the greater curvature. The microscopic examination disclosed no significant findings.

The postoperative course was uneventful until the eighth postoperative day, when the patient became markedly distended, and developed the clinical picture of large bowel obstruction. A tube cecostomy was performed and the patient recovered rapidly. Subsequently a barium enema failed to disclose any colonic pathology. Un-

eventful recovery ensued after this temporary set-back for which no cause had been found. The jejunostomy tube was removed on the 15th postoperative day.

On March 11, 1944, gastroscopy was repeated. The ulcerated area, previously observed, now appeared as a depressed scar about 1.5 cm. wide.

The patient's weight on the day of discharge, 30 days after the original operation, was 73.5 pounds.

The patient was last seen in the Follow-up Clinic on June 13, 1945. Her weight was 106 pounds, a gain of 25 pounds. She has had no pain, no vomiting, and was having regular bowel movements daily. A Rehfuss test meal, April 11, 1945, showed no free acid. The combined acids measured 16 millimoles per cent. Gastroscopy, April 23, 1945, disclosed a depressed scarred area at the site of the ulcer visualized preoperatively. No ulceration was seen. Roentgenograms of the stomach, April 10, 1945 (Fig. 3B), showed a stomach upon which a subtotal gastrectomy had been performed. A constant incisura was present on the greater curvature opposite a point on the lesser curvature, towards which several radiating mucosal folds converge. The point of convergence corresponds to the localization of the previously described ulcer. The stoma was normal.

The patient was well until October 30, 1945, when she took suddenly ill and was taken to City Hospital (No. 136209-45). She died two days later. Autopsy revealed bronchopneumonia, chronic glomerulonephritis and arteriosclerotic heart disease. There was an old completely healed gastric ulcer.

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DISCUSSION.—DR. RICHARD H. SWEET, Boston, Mass.: It occurred to me while listening to Doctor Colp's very interesting paper that it might be appropriate to mention that this problem can be approached from a different point of view, namely, to operate upon patients with a high right gastric ulcer by the transthoracic approach. It is possible in this way to remove the ulcer in all cases and to preserve a portion of the stomach, with which one can perform an esophagogastric anastomosis. Much of the acid-producing portion of the stomach remains, but the fact that the vagus nerves have been sectioned may lead to a reduction in the secretion of acid, which may contribute to the success of the operation.

DR. RALPH COLP, New York City (closing): Of course, the advantage of Doctor Sweet's operation is that the ulcer is removed, but in the hands of most surgeons I believe the mortality would far transcend the mortality of nonremoval of a benign ulcer by a palliative gastrectomy.

SUBTOTAL GASTRECTOMY FOR DUODENAL ULCER*

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A CERTAIN NUMBER of patients with chronic duodenal ulcer must be treated surgically. This group represents from 10 to 15 per cent of all cases of duodenal ulcer coming to a large general hospital. It consists of ulcer patients in varying degrees of chronicity who have developed cicatricial stenosis, those who bleed massively with each exacerbation, and those who continue to have pain on the best ambulatory medical regimen known. Surgeons throughout the world, by the method of trial and error, have achieved almost universal agreement regarding the type of operation likeliest to succeed in such cases. Resection of the distal stomach of sufficient extent to eliminate all the acid activating antral mucosa appears to offer the greatest opportunity for cure. To accomplish this, it is usually technically easier to include a generous portion of the acid-producing fundus. It is possible that this secondary consideration influences the results of operation in both directions. On the one hand, this makes it more certain to include all the antral cells, particularly those located high on the lesser curvature, but on the other hand, this extensive resection of fundus may well account for some of the late nutritional and functional problems that sometimes arise. The decrease in operative mortality accompanying better surgical methods in general and greater experience in particular has a tendency to increase the rate of radical *versus* conservative measures in the treatment of borderline cases.

Dragstedt and his coworkers[1] have recently suggested the possibility of avoiding most of the operations upon the stomach itself by transthoracic vagotomy. Moore, Jones, *et al.*,[2] in our clinic, have satisfactorily demonstrated in a carefully selected group of ulcer patients that this procedure is spectacular in its immediate results. It will require time and more extensive experience with this indirect attack on the problem to evaluate the ultimate outcome in these cases.

In the meantime, it is essential that the accumulated experience of surgeons who have treated duodenal ulcer by radical surgery be assembled. Rienhoff[3] has already presented his results on a large group of patients treated by partial gastrectomy. It is our intention in this report to consider only those patients primarily subjected to gastric resection for duodenal ulcer by the senior author. This will eliminate variables that would of necessity exist in data collected from the hospital as a whole. The follow-up studies, carried out mainly by the coauthor, chiefly include private cases, although some were ward patients. We have excluded a sizeable group of patients who had had previous but unsatisfactory surgery for duodenal ulcer elsewhere. We have included cases operated upon during the acute phase of massive hemorrhage.

* Read before the American Surgical Association, April 2–4, 1946, Hot Springs, Virginia.

INDICATIONS FOR OPERATION

Cicatricial stenosis results from long-standing ulcer with repeated episodes of activity. Usually these patients are in the older age-group, and present themselves in a state of malnutrition with either spontaneous or self-induced vomiting at least once in 24 hours. The stomach is large, and barium leaves the pylorus slowly. These patients improve slightly on gastric drainage and intravenous therapy. It is difficult by these methods to correct their chemical imbalance. The gastric acidity is low, and this leads to the erroneous assumption that their ulcer tendency is past. It is often assumed that these patients may be relieved by gastro-enterostomy or pyloroplasty. After observing two elderly men develop anastomotic ulcer following this reasoning, it seemed to us that more radical measures should be adopted. These patients are devoid of excess fat, and the scar of the ulcer area usually is just distal to the pylorus. These factors make them particularly satisfactory for subtotal resection. We have employed this radical type of operation upon this type of patient in recent years,[4] with no regrets.

It should be remembered that many ulcer patients become temporarily obstructed during acute exacerbations. These have a more sudden onset of symptoms occurring at any age, and enter the hospital in a good state of nutrition. Such patients always respond to gastric drainage and intravenous therapy within a week or ten days, after which time conservative treatment may be the procedure of choice.

Massive hemorrhage from duodenal ulcer indicates that the ulcer overlies the gastroduodenal artery or one of its radicals. Years ago, we[5] pointed out that under proper hospital management a high percentage of these patients spontaneously recover from such an episode. Certainly, death from acute anemia rarely occurred in young persons. In patients beyond the fifth decade, however, such an ulcer would not respond to conservative therapy in one-third of the cases. Whether or not a patient spontaneously ceased to bleed had no relation to the chronicity of the ulcer or the number of episodes of bleeding. Age and the degree of arteriosclerosis present seemed to be the only factors on which one could rely regarding prognosis. This led us to adopt conservative treatment in patients under the age of 45 and the careful weighing of all evidence for early operation in those beyond this age. Exceptions to this general rule have been met, and an occasional young person will bleed to death despite all that can be done. We learned early in our experience that massive hemorrhage occurring repeatedly over a period of several days is nearly always surgically hopeless. This, we believe, is due to the loss of tissue substances from lack of food absorption, which cannot be adequately replaced by artificial methods. Thus, only one patient survived radical surgery after the seventh day of bleeding. There were, however, 11 successful resections in 12 patients, all in the older age-group, who were operated upon within 72 hours of the initial hemorrhage.

It was postulated that the Meulengracht[6] system of feeding patients who

were bleeding might extend the time limit for safe operation. Also, one may consider the better operative state of such a patient who has had intravenous amino-acids, as well as blood, plasma, water, salt and sugar. So far, we are convinced that patients are not benefited by the forced ingestion of food while the intestine is filled with blood. This is particularly true when the patient has nausea and vomits blood that has passed into the stomach from the duodenum. If he is hungry, he will be improved by the ingestion of finely divided food, regardless of the stage of bleeding. The results, reported so profusely in the literature regarding the magic of feeding during massive hemorrhage, fail, in nearly every case, to take into account the age of the patients dealt with. The younger ones nearly always recover regardless of treatment, whereas a large percentage of the older patients continue to succumb unless subjected to operation early during their bleeding episode. We have assumed that this variation is due to the difficulty with which firm thrombus formation takes place in a more or less rigid arteriosclerotic blood vessel. There may well be undertermined factors influencing the situation. Huge doses of vitamin K have been helpful, since a number of these patients with massive bleeding have a measurable elevation of the prothrombin time.

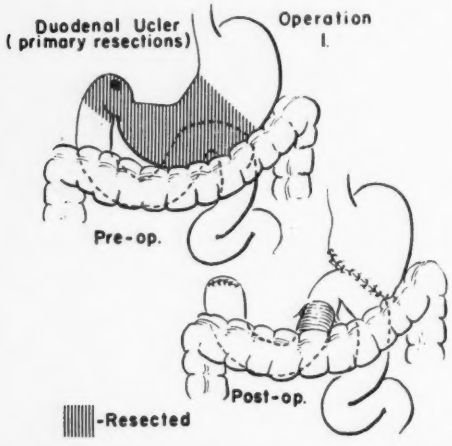

FIG. 1.—Operation I for duodenal ulcer. The resected specimen shown by heavy vertical lines includes the lower two-thirds of the stomach and the duodenal ulcer. Continuity is restored by means of a posterior Hoffmeister anastomosis.

In the interval state of the duodenal ulcer that bleeds massively on activation, one must consider seriously the advisability of such a patient's submitting to surgery at a time of election. We have been impressed by the appreciable percentage of ulcer patients who have little or no warning of exacerbations. This may be due to a high pain threshold, as pointed out by Chapman, *et al.*[7] Perhaps there is a variation in pain pathways from this region in some patients. Regardless of the explanation of this situation, those who perforate or who bleed massively without warning should, at a suitable time, be offered surgical protection against future episodes. It also appears that patients who have bled massively are less likely to remain symptom free on conservative measures than is the average person with duodenal ulcer. This may be due to the location of the ulcer under these circumstances, since healing of the completely eroded thin, posterior wall of the duodenum is represented by fixed scar tissue in or on the pancreas.

Intractable pain has been considered by Hinton[8] the most valid reason for subjecting a patient with duodenal ulcer to surgery. We have used this term loosely to include some patients who, with a better economic or intellectual

status, might well have continued on conservative measures. These patients have varied tremendously, and their selection for surgery has given us much concern. It is in this group that we have had some of our most outstanding successes, as well as some of our most dismal failures. These include persons who are intelligent, prosperous, happily married and otherwise well, only to have continuous discomfort when the stomach is empty of food or added alkalies. In one such patient, after three weeks of hospital management, sleep was possible only while a continuous drip of aluminum hydroxide was administered through a nasal catheter. This man, overweight from hourly feedings of milk and cream but weakened by his enforced bedrest, succumbed to coronary thrombosis 48 hours after subtotal gastrectomy. Some patients in this group, particularly those with low intelligence who are worried about finances and family and have uncoöperative and vigorous spouses, willingly submit to or even beg for surgery. They are prone to be the ones who are unhappy with the operative result and are unable to cope with life in general. They have a different set of postoperative complaints, but these are referable mainly to the gastro-intestinal tract. It is in such patients that psychiatric aid should be solicited before and not after surgery. Some such cases are referred to the surgeon by the internist because the latter believes that he cannot keep these patients well enough to do their job in life on a conservative regimen.

TECHNICAL CONSIDERATIONS

Based on our own observations and those of others, we have assumed that the operation, if undertaken, should attempt removal of the distal two-thirds of the stomach and the ulcer-bearing segment of the duodenum. As evidenced by our early failures due to technical difficulties with the duodenal stump, it soon became obvious that, at least in our hands, the risk was too great to pursue this supposedly ideal procedure in all cases. Although it is possible by a tedious, painstaking dissection with repair or reimplantation of the common bile duct in certain inflammatory extensions from duodenal ulcer to achieve a happy outcome, this, too often led to complications, sometimes fatal, to warrant a continuation of this routine. This prompted us to do, in a small group of cases, resections for exclusion by turning in a segment of the antrum without excision of the mucosa; the results, however, were unsatisfactory. Other modifications designed to obtain an adequate resection have been more successful, and the whole series breaks-up into four main categories:

Group I: When patients can be operated upon during a quiescent phase, and the inflammatory reaction is at a minimum, it is usually possible to resect the ulcer area in the duodenum without difficulty. The foreshortening of the duodenum from scar tissue may, even in this chronic state, leave too little room between the ulcer and the ampulla of Vater or the hepatic artery to allow a safe and satisfactory inversion of the duodenal stump. In Group I, we have included those cases in which part or all of the ulcer scar was used in the closure of the duodenum. This may confuse the issue to some extent, but we believe that the

ultimate results are unchanged by this procedure. Thus, there are 139 cases in this group, the results of which can be seen in Table I.

Group II: In 18 patients the ulcer was far enough distal to the pylorus to allow a transection of the duodenum above the ulcer and to leave room for an adequate closure. In these cases, removal of the ulcer itself might have led to disturbance of the bile ducts, which we have found so tedious to repair or reimplant. Although the number of such cases is small, it appears that they have done as well as those in Group I. In some of these, if not all, we believe that even a second-stage operation on the distal segment six weeks later might have been difficult to carry out. It is important that early dissection to determine the extent of the ulceration must be done with the greatest of care. Often

TABLE 1

DUODENAL ULCER—PRIMARY RESECTIONS
DISTRIBUTION OF CASES AND MORTALITY

	Type of Operation					
	I	II	III	IV	Finsterer	Total
Number of cases	139	18	27	3	8	195
Deaths	7*	2†	0	0	1	10
Mortality %	5.1	11.1	0	0	12.5	5.1

* Includes 4 deaths—late massive hemorrhage.
† Includes 1 death—late massive hemorrhage.
Mortality, elective resections—2.6%.

this procedure, which should, up to a point, be routine, has led us into the commitment of a prolonged dissection when a less extensive alternative was available. Certainly, it is necessary in all cases in which primary resection is contemplated to determine the course and direction of the common bile duct. If, however, such maneuvers lead one into the ulcer at a low level in the duodenum, there is no other choice than to proceed with complete removal of the ulcer. In one patient where this dissection was abandoned after finding the ulcer actually in the third portion of the duodenum, death occurred from perforation of the ulcer three days after subtotal gastric resection for exclusion. On this man, we had previously closed a gastrojejunocolic fistula. He had refused further surgery until his second episode of massive hemorrhage two years later.

Group III: In these patients we have used transection of the antrum proximal to the pylorus with excision of the mucosa from this segment, in addition to a generous gastric resection. This method was suggested in Finsterer's[9] original communication on resection for exclusion. Later, he stated that this small segment of antral mucosa could be left *in situ* if it was accompanied by a sufficiently high gastrectomy. Finsterer subsequently regretted this, and the almost universal failure when antral mucosa has been left behind is common knowledge to us all.

There were two poor results in this group. One patient, thought to have had an adequate procedure, developed an anastomotic ulcer two years later, which healed after excision of the antral segment and the first portion of the duodenum. In this segment, antral mucosal cells were found near the pyloric ring that had apparently grown from a nidus left at the original operation. He has remained well since. Another patient since operation has had episodes of bleeding of undetermined origin. It has not been possible to demonstrate an anastomotic ulcer in his case, and gastroscopy has revealed marked gastritis in the proximal stomach segment. He could probably be relieved by a removal of the antral segment but has refused further surgery. He is obese and indulges in highly seasoned food and alcoholic beverages. In the remaining cases suitable at this time for follow-up, the results are as good as those in Group I.

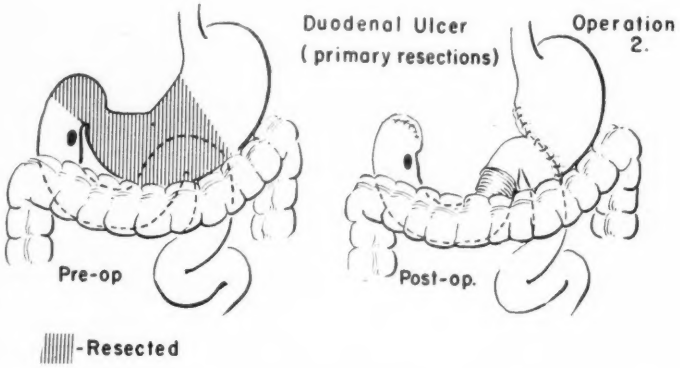

FIG. 2.—Operation II for duodenal ulcer. The resected specimen does not include the ulcer which is located in the second portion of the duodenum. Normal duodenum is closed proximal to the ulcer, thus excluding the ulcer.

The technical difficulties of complete removal of the antral mucosa and a satisfactory closure of the remaining tissue have made this procedure somewhat unpopular. With care, the mucosa can be separated without damage to the thin posterior wall of the antrum. The dissection within a more or less constricted pyloric ring is sometimes difficult, and bleeding in this area may be troublesome. We have always closed the denuded segment by inversion, but Wangensteen[10] has advocated closure by apposition, as suggested by Estes[11] and Scrimger.[12]

Group IV: McKittrick,[13] *et al.*, have advocated a two-stage attack on certain patients with duodenal ulcer. His premise is well taken, in that the young surgeon during his formative period may not be able to use proper judgment in the selection of procedure under all circumstances. Gastrectomy with anastomosis is a simple matter, but the management of the duodenal stump is often complicated. This is well-borne out by our early experience in this field. Six weeks after the original operation, the antral segment can be removed with

greater safety, since the inflammatory reaction about the ulcer has largely subsided. This division of the procedure has all the disadvantages of any two-stage operation. It does, however, reduce the risk in complicated cases in any hands, especially those unfamiliar with the many pitfalls encountered in such operations. Although we have deliberately planned such a procedure in only three patients, we believe that the principle is sound and should be more widely used. It is possible that all patients in Group III should be warned that a second stage may eventually be necessary. As a matter of fact, further studies may reveal that, in order of preference, Group IV should take precedence over Group III.

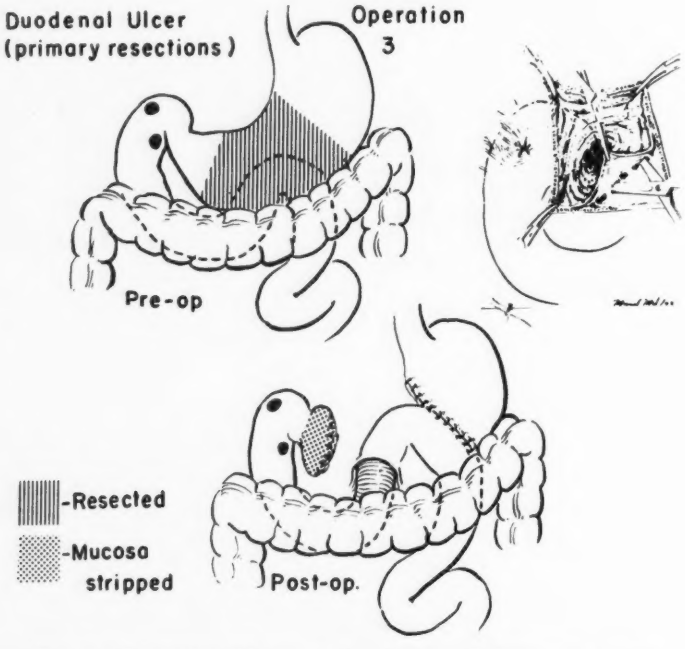

FIG. 3.—Operation III for duodenal ulcer. Inflammatory adhesions about the ulcer make it impossible to mobilize the duodenum. The stomach is transected proximal to the pylorus and the mucous membrane removed. The pyloric muscle is then closed.

OPERATIVE PROCEDURE

Transverse incisions have been used in our patients who have a flaring costal angle and in those with low-lying stomachs. This approach has some advantages but is not suitable for patients with a narrow costal angle or those with high transverse stomachs. In the latter group, we prefer a left rectus muscle-retracting incision. We believe that either of these will result in fewer weak wounds than the ones that occur following the midline approach. Interrupted nonabsorbable sutures in the fascia and careful closure of the dead space in the fat have eliminated wound dehiscence and hernia in the scar.

Inspection of the ulcer area, with sufficient lysis of adhesions to determine the relation of the inflammatory reaction to the common bile duct, is the preliminary step in the operation. One may be able to determine at this time which procedure can be more safely carried out. As mentioned before, too much dissection of this area early in the operation may result in an unnecessarily tedious and prolonged operation or leave a low-lying ulcer exposed to acute perforation.

We prefer to free the greater curvature of the stomach first, starting well above the junction of the right and left gastro-epiploic vessels. The left gastric vessels are interrupted proximal to their spread in the lesser curvature. Transection of the stomach between Payr's clamps at right angles to the curvatures is then done, including the lesser curvature at the highest level feasible. The distal

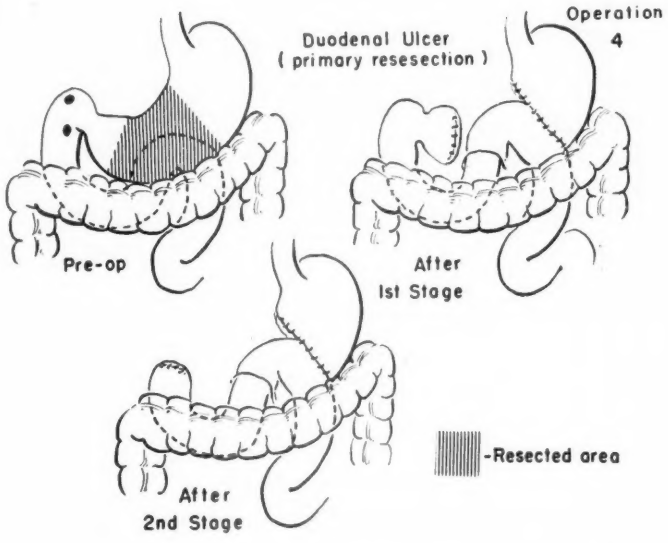

FIG. 4.—Operation IV for duodenal ulcer. The stomach is transected proximal to the pylorus. The mucous membrane is not removed, and the pylorus closed. Six weeks later, at the second stage, the pylorus and ulcer bearing portion of the duodenum are resected.

segment can then be manipulated in such a manner that the adherent area about the involved duodenum can be exposed from all directions. We have inverted the duodenal stump with two continuous rows and one interrupted row of fine chromic catgut. It requires approximately 2 cm. of free duodenum to accomplish this easily, and we have been content to leave some of the normal or abnormal adherence of the posterior duodenal wall to the pancreas distal to the suture line.

We have occasionally used the entire cut-surface of the proximal stomach segment in the anastomosis, but most often we have closed the upper third using the remaining two-thirds for the stoma. The jejunum is anastomosed to the

stomach as close to the ligament of Treitz as possible in a retrocolic isoperistaltic hook-up. The rent in the transverse mesocolon is carefully attached to the stomach segment above the anastomosis with interrupted cotton sutures. Two rows of fine continuous chromic catgut only are used in the anastomosis, with care to invert all of the mucous membrane.

Several years ago, we[14] advocated jejunostomy for feeding in pre- and postoperative stomach resections. Later we[15] suggested proximal jejunostomy for decompression of the postoperative stomach. The latter procedure has been used by us in 246 patients. The feeding jejunostomy is not routine but is useful in patients who are below par preoperatively. Lately, we have used this tube routinely in an attempt to prevent weight-loss during early convalescence. No fatal complication has resulted from the use of either of these tubes. No case of intestinal obstruction has occurred as we feared might take place around the fixed point. Three cases of minor localized infection within the peritoneal cavity have occurred, delaying discharge from the hospital about one week. One erosion of the deep epigastric artery required exposure and ligature. We often insert the tubes and then use only the proximal one intermittently for two or three days. Occasionally these tubes are invaluable in the management of a temporarily malfunctioning stoma. Patients are grateful for the elimination of the nasal catheter postoperatively. A few have complained of mild discomfort at the site of the fixed jejunum to the abdominal wall for a short while after discharge from the hospital. Minor infection about the tube is usual. We believe that the tubes should not be withdrawn until after the 12th postoperative day. No patient has developed a fistula at this site. After removal of the tube, there is practically no discharge of jejunal contents and the wounds are dry within 48 hours.

IMMEDIATE RESULTS

In tabulating the results from operations on the stomach, one must bear in mind factors that may influence our deductions. The operative mortality is fixed and definite, and may not be so important when dealing with otherwise hopeless situations. It is, however, to be remembered that duodenal ulcer is a benign lesion that usually responds to conservative measures. It may be debated whether or not we should justifiably consider the late efforts to rescue patients dying from massive bleeding as operative fatalities. When, however, the opportunity comes at a time known to the surgeon as "too late," it is difficult for him to refuse, since a rare success occurs under these circumstances. There is no doubt concerning the value of experience regarding mortality, but everyone can point out a reduction in deaths during the past few years. The elimination of peritonitis and pulmonary complications often attributed to the advent of chemotherapeutic agents may, in fact, be mainly due to advances in preparation, anesthesia, surgical technic and aftercare.

Reference to Table II will show that there were five deaths in the patients who had resection at the time of election. Two were due to coronary thrombosis, and one to pneumonia. Two patients with large ulcers died postoperatively of

peritonitis. With the exception of one of the deaths from coronary thrombosis, all occurred in the era before the introduction of sulfonamides and penicillin.

The patients who died after operation for acute massive hemorrhage were uniformly operated upon after several days of bleeding as a final gesture. The five patients who succumbed under these circumstances died within a few days after operation. If they survived the period of hemorrhage and shock, they died promptly of peritonitis or pneumonia.

The advent of better anesthesia, chemotherapy and frequent transfusion has been of immense aid in lowering the mortality. Thus, the mortality in the first 50 cases of this series was 12 per cent, and that of the next 50 was six per cent, whereas in the last 100 there was only one death. A series of cases extending throughout 1942, 1943, 1944 and a portion of 1945 was broken after 103 successes by the death from coronary occlusion mentioned above.

TABLE II

DUODENAL ULCER—PRIMARY RESECTIONS
COMPLICATIONS AND DEATHS

	Elective Resections		Late Resections for Acute Massive Hemorrhage	
	Nonfatal	Fatal	Nonfatal	Fatal
Hemorrhage, shock	1	0	0	2
Sepsis:				
Peritonitis	0	2	0	1
Leaking duodenal stump	1	0	0	1
Necrosis antral stump	1	0	0	0
Leak at jejunostomy site	1	0	0	0
Wound sepsis	2	0	0	0
Pancreatic abscess	1	0	0	0
Cardiorespiratory:				
Pneumonia	0	1	0	1
Atelectasis	3	0	0	0
Coronary thrombosis	0	2	0	0
Thrombo-embolism	6	0	0	0
Stomal obstruction	5	0	0	0
Miscellaneous:				
Minor dehiscence	1	0	0	0
Diazine reaction	1	0	0	0
Ulnar paralysis	1	0	0	0
Total	24	5	0	5

Nonfatal complications during immediate convalescence are rarely emphasized. They are, however, occasionally so serious that one considers them sublethal in character. Pulmonary emboli from bland thromboses in the deep veins of the leg are now so well recognized as a possible complication following bedrest that one should be able to eliminate most of them. On the other hand, those who are particularly alert to this possibility still have patients whose immediate recovery is prolonged by pulmonary infarcts. Fortunately, we have had little trouble with leaking or bleeding suture lines. We have not found it necessary to reëxplore the patient for malfunctioning stoma since we have employed double jejunostomy tubes. Collections of pancreatic fluid, following the

removal of duodenal ulcers penetrating the pancreas, have caused us much concern on occasion. We have found it necessary to drain such areas secondarily in a few cases. In one patient, gradual stenosis of the transpancreatic portion of the common bile duct occurred, requiring reëstablishment of continuity six months later by a method previously described by us.[16] The stormy convalescence occasionally seen is ever present in our minds. We realize that the narrow margin of safety, under these circumstances, could easily influence mortality results. It is possible to avoid most of these disturbing situations by the proper selection of the type of procedure chosen to fit the conditions met.

TABLE III

DUODENAL ULCER—PRIMARY RESECTIONS
DISTRIBUTION OF FOLLOWED CASES

	Type of Operation					
	I	II	III	IV	Finsterer	Total
Followed 1-14 years	93	14	21	1	7	136
Too early for evaluation	24	1	5	2	0	32
Operative deaths	7	2	0	0	1	10
Lost	15	1	1	0	0	17
Total	139	18	27	3	8	195

LATE RESULTS

In embarking on a radical attempt to relieve a patient with duodenal ulcer no longer responsive to conservative treatment, one must take into consideration the ultimate as well as the immediate result.

To be eligible for follow-up studies, it was necessary to exclude operations performed in 1945 and 1946, since it is still too early to evaluate the results. Seventeen patients have been lost, leaving 136 available for study (Table III).

In judging the late results of operation, we have eliminated the small group of Finsterer resections, which we soon found were entirely unsatisfactory (Table IV).

The remaining 129 patients were classified as excellent, satisfactory, or poor (Table V). Patients graded "excellent" and entirely asymptomatic comprised 69 per cent of the entire group. An additional 18 per cent had trivial symptoms, such as intolerance to a fatty meal or a rare attack of nausea after a heavy meal; these, too, were included in the excellent results. About six per cent of the patients were improved by the operation but still have symptoms requiring a special diet or medical care; these results are listed as "satisfactory." Definitely poor results occurred in about seven per cent of the group.

A happy outcome accompanying a smooth convalescence with continued freedom from pain and other disturbances takes place in the large majority of cases. Patients enthusiastically state that they are free of discomfort for the first time in many years and that they eat anything they choose and as much of

it as they can get. They work harder than ever before and wonder why this relief had not been offered to them earlier in their lives. Many others are relieved of ulcer pain but continue to eat small meals because of discomfort or nausea accompanying overindulgence.

Persistent gastro-intestinal symptoms of some degree will occur in about a third of the cases. Those that occur in the excellent and satisfactory groups are analyzed in Table VI. The most frequent residual symptom is that of a "small stomach," *i.e.*, the inability to eat a full meal and discomfort, gas or nausea after eating. Less common, but more troublesome, are the symptoms of the "dumping stomach." Such patients have a sense of exhaustion or weakness after meals and occasionally have a rapid pulse, perspiration or vertigo, followed by diarrhea or lower abdominal cramps. These symptoms are often

TABLE IV

DUODENAL ULCER—PRIMARY RESECTIONS
FOLLOWED CASES—RESULTS ACCORDING TO TYPE OF OPERATION

	I	II	III	IV	Finsterer	Total
Excellent	82	12	17	1	1	113
Satisfactory	5	1	2	0	0	8
Poor	6	1	2	0	6	15
Total	93	14	21	1	7	136

alleviated by dietary measures. This group is especially intolerant of a high-fat intake and can be benefited by a high-protein diet. Most of the symptoms listed in this table are not important enough to trouble the patient, and can be elicited only by careful questioning; they do occur, however, in nearly a third of our postoperative patients. It must be remembered, in this regard, that a control series of theoretically normal people will show similar symptoms in 10 to 20 per cent of the group (St. John, *et al.*[17]).

Weight changes after resection are interesting. A considerable number of patients gain weight, whereas a larger percentage have difficulty acquiring their normal weight and cannot eat enough to gain while carrying on their work. It will be noted that although weight-loss is frequent, symptoms arising from it are unusual. Men appear to have less difficulty in this regard than women. Young and middle-aged men feel well at their "college weight" and are somewhat proud of it, whereas the older man resents his appearance. It is difficult to see why two individuals having the same amount of stomach removed should behave so differently. We agree with Rienhoff that weight-loss never becomes a problem to the gourmet, and that the patient who has never really enjoyed food has more difficulty in taking an adequate number of calories each day. We find that the average weight-loss is nearly twice as high in women as it is in men. Patients who have been operated upon for obstruction lose the least weight, whereas those whose resection was for pain or bleeding lose the most. (Table VII).

Paralleling these weight changes, it is also of interest that the postoperative results are better in men than in women (Table VIII). Women appear to have more symptoms from the small postresection stomach than do men, and in view of the rarity of jejunal ulcer in women, it is possible that resection should be less radical in women than in men.

The results classified as poor fall into three groups: anastomotic ulcers, recurrent gastric hemorrhages and severe postresection symptoms (Table IX).

TABLE V

DUODENAL ULCER—PRIMARY RESECTIONS
FOLLOWED CASES—RESULTS
(*Finsterer Operations Excluded*)

	No.	Per Cent
Excellent		
Asymptomatic	89	69.0
Trivial symptoms	23	18.0
Total	112	87.0
Satisfactory	8	6.1
Poor	9	6.9
	129	100.0

TABLE VI

DUODENAL ULCER—PRIMARY RESECTIONS
ANALYSIS OF EXCELLENT AND SATISFACTORY RESULTS
(*Finsterer Operations Excluded*)

Symptoms referable to a small stomach		24
Inability to eat a full meal or loss of appetite	10	
Occasional nausea after eating	8	
Discomfort or gas after eating	4	
Rare vomiting	2	
Symptoms referable to rapid emptying of stomach		15
Exhaustion, weakness, vertigo, rapid pulse, perspiration after eating	7	
Diarrhea, occasional or persistent	6	
Lower abdominal pain after eating	2	
Symptoms of weight loss or inability to gain		5
Symptoms of secondary anemia		2
Symptoms of hypoglycemia		2
Special food intolerance		22
Fats	5	
Carbohydrates	4	
Milk	3	
Cheese	2	
Chocolate, cabbage, spaghetti, raw vegetables, citrus fruits, coffee, hot drinks, cold drinks—1 each	8	
Total symptoms	70	
Total patients with symptoms	31	
Average number symptoms per patient	2+	

Three patients have been encountered in each group. Those in the last group could probably be improved by a change in domestic environment or psychotherapy, but at present they are unhappy with reference of their symptoms to the gastro-intestinal tract.

Three patients, all resected primarily for hemorrhage, have had recurrent bleeding, 3, 4 and 7 years postoperatively, respectively. In two of them the

diagnosis of gastritis has been established by roentgenologic examination and gastroscopy. They have not been subjected to further surgery, although it is possible that vagotomy might cure them.

Evidence of continued ulcer activity, following a supposedly adequate stomach resection for duodenal ulcer is, after all, the most serious type of failure. Anastomotic ulcer, reviewed by us[18] from the records of the Massachusetts General Hospital, revealed that one-third of them appeared during the first postoperative year. A second third occurred during the second year, while the remaining third was spread from 3 to 18 years after operation. For this reason,

TABLE VII

DUODENAL ULCER—PRIMARY RESECTIONS
CHANGE IN WEIGHT POSTRESECTION IN POUNDS

	Indication for Resection			Average
	Bleeding	Pain	Obstruction	(All Cases)
Males	— 6	— 7	— 4	— 6
Females	—25	—14	+10	—13

Weight loss in 61% of patients.
No change in 16%.
Gain in 23%.

TABLE VIII

DUODENAL ULCER—PRIMARY RESECTIONS
FOLLOW-UP RESULTS ACCORDING TO SEX
(*Finsterer Operations Excluded*)

	Males		Females	
	No.	Per Cent	No.	Per Cent
Excellent	95	90.5	17	71
Satisfactory	3	2.9	5	21
Poor	7	6.6	2	8
Total	105	100.0	24	100

we realize that there is still time for many of our cases now classified as excellent results to develop this late complication. Although jejunal ulcer has occurred rarely in our series, we are impressed by the complete lack of symptoms for ten years in one patient, who has recently appeared with a large anastomotic ulcer. This man has been spectacularly relieved for the time being by transthoracic vagotomy. A second patient, who developed a jejunal ulcer, was relieved by a higher resection, and the third by excision of the antral segment.

We can easily explain the development of early anastomotic ulcer on the basis of antral mucosa left *in situ*. Since two-thirds of these cases occur within the first two years after operation, it seems reasonable to suppose that a technical fault in the procedure should be looked for. We have already described the difficulties met in removing all antral mucosa from a distal segment of

stomach left for closure. We believe, however, that all the antral cells, which so often extend high on the lesser curvature, are not included in many resections. It is interesting to note that the specimens of stomach removed average 11 cm. in length on the lesser curvature in the most successful cases. If the same area measures less than 10 cm., anastomotic ulcer may occur. We have frequently been impressed by the narrow margin of safety seen in our own specimens.

We believe that the anastomosis between the proximal stomach segment and the jejunum should be made as near the duodenojejunal junction as possible. This is based on a few instances of early unsatisfactory experiences with antecolic anastomosis. Lannin[19] in Wangensteen's Clinic brought experimental and clinical evidence forward to support posterior short-loop anastomosis. In that

TABLE IX

DUODENAL ULCER—PRIMARY RESECTIONS
ANALYSIS OF POOR RESULTS

(*Finsterer Operations Excluded*)

	No.
Anastomotic ulcer	3
One, 2 years postresection—secondary resection	
One, 10 years postresection—vagotomy	
One, 1 year postresection—treatment elsewhere	
Postoperative hemorrhage	3
One, 7 years postresection—diagnosis gastritis	
One, 4 years postresection—diagnosis gastritis	
One, 3 years postresection—treatment elsewhere; no diagnosis	
Severe postresection symptoms	3
Two, nausea, vomiting, marked loss of weight	
One, intolerance to food, palpitation, weight loss, avitaminosis	
Total poor results	9

clinic it has been demonstrated in laboratory animals that the incidence of anastomotic ulcer is increased by each additional few centimeters of the small intestine proximal to the anastomosis. This ranges from zero at the duodenojejunal junction to 100 per cent in the terminal ileum. There are in other clinics large groups of patients available for study who have had antecolic anastomosis following subtotal gastrectomy for duodenal ulcer. It will be of interest to compare the groups of patients who have had antecolic and postcolic anastomoses when all these data are available. It should be remembered that anastomotic ulcer is not a sequel to gastro-enterostomy following stomach resection for gastric ulcer. It is hoped that authors will bear this in mind in reporting their results, and that duodenal and gastric ulcers will be reported in separate groups.

It is by further follow-up studies that a true evaluation of subtotal gastrectomy for duodenal ulcer can be made. It may be that we have deluded ourselves regarding this procedure. Such an opinion has long been held by Heuer,[20] and others. It has always seemed probable that a more satisfactory and less radical method of dealing with duodenal ulcer than subtotal gastrectomy would eventually be found. We are certain that the results obtained are more nearly

satisfactory by this method of surgical approach than those by any other that we have tried. We believe, however, that such a procedure may not be quite so good as we had hoped for when considered from every angle. A more rational approach to this derangement of physiology may well be found. Transthoracic vagotomy as advocated by Dragstedt may prove to be the best answer to the problem at this time.

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DISCUSSION.—DR. LESTER R. DRAGSTEDT, Chicago, Ill.: I have been very much interested in this critical analysis of results obtained in the treatment of duodenal ulcer by subtotal gastrectomy. It seems to me it is well worth while to make such a critical evaluation of the present status of this operation at this time because, as Doctor Allen has so generously stated, we have now available an alternative method. During the past three years I have sectioned the vagus nerves to the stomach in 67 patients with peptic ulcers of various types—duodenal, gastrojejunal and gastric. The

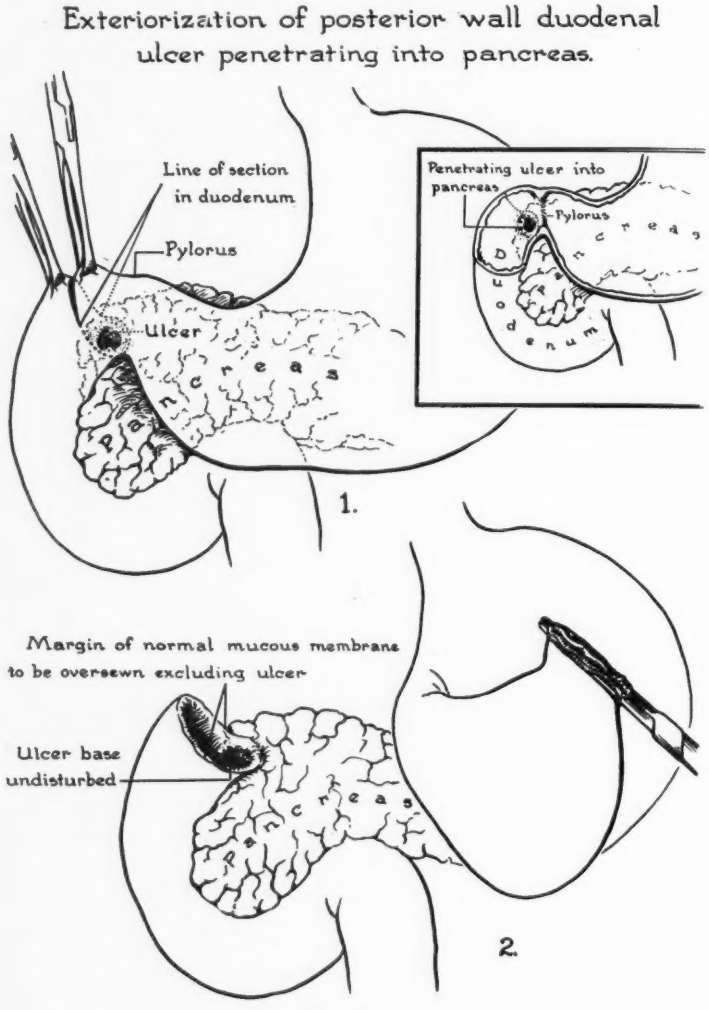

FIG. 1

results so far have been so satisfactory that I think there is a real possibility that it will replace subtotal gastrectomy in the treatment of this disease. In order to make such a decision, it is important to get postoperative data on patients who have had subtotal gastrectomy. I refer particularly to the nutritive status of the patients who have lost so important a digestive organ as the stomach. I have long felt that this is too disabling an operation for a benign lesion.

DR. ROSCOE R. GRAHAM, Toronto, Ont.: We are indebted to Doctor Allen for many things, not the least for his critical analysis of the results of his operative therapy for duodenal ulcer. There is the hope that not many years hence a gastric resection for duodenal ulcer may be replaced by more rational therapy. Doctor Dragstedt's work is indeed stimulating. The hazard of a gastric resection for duodenal ulcer centers largely about the closure of the duodenum. I should like to present a method of closure of the duodenal stump in difficult penetrating posterior wall ulcers by exteriorization of the ulcer base. The duodenum is adequately mobilized and the

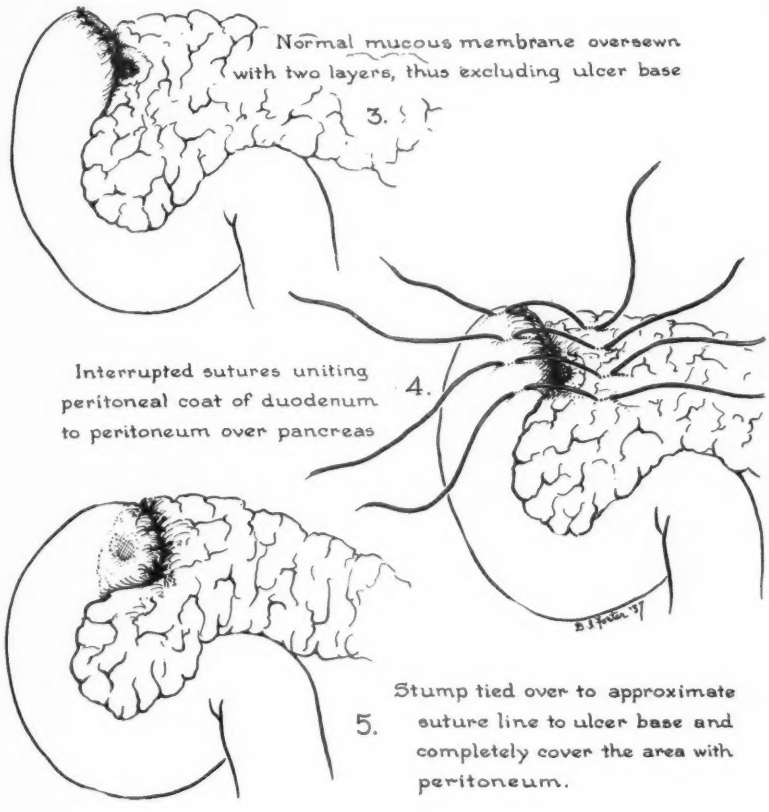

FIG. 2

common bile duct is visualized. The duodenum is then boldly opened and divided so that all the mucous membrane on the medial side of the ulcer is removed (Fig. 1). No effort should be made to separate the lateral side of the ulcer base from the posteromedial quadrant of the duodenal stump. Not only is this unnecessary, but attempts to do so produce not only hemorrhage but gross tissue trauma. The duodenal stump can then be closed without tension, leaving the ulcer base outside the lumen. The closed stump is then held against the ulcer base by sutures which unite the peritoneum over the pancreas with that on the lateral side of the duodenum, thus, completely retroperitonizing the closure (Fig. 2). This has given us happy results.

Doctor Allen has mentioned one of the unexplained syndromes following gastric resection; the patient who, after a meal, usually breakfast, becomes nauseated, pale, sweating and weak. These distressing symptoms are relieved by recumbency, and rarely last longer than half an hour. The roentgenologic study of such patients with a barium meal showed that in the early group where we had made a large stoma, there was a reflux of gastric contents into the proximal jejunal loop. We now make a small stoma and suture the proximal jejunal loop up on the stomach so that there is formed a valve. The entrance of the proximal jejunum is at a much higher level than the efferent jejunal loop. This was originally suggested by Finsterer to further secure the gastric suture line. While this technic has not eliminated this postoperative syndrome, it has become much more infrequent.

DR. G. GAVIN MILLER, Montreal, Quebec: The subject of subtotal resection for gastroduodenal ulcer covers a wide field, and I would like to restrict myself to only one point, namely, the question of nutrition. In a definite percentage of cases who have undergone resection, weight-loss, weakness, anorexia, and occasionally dizziness and nausea persist. Blood sugar curves show an early and high rise to 200, or even 300 mg. per cent, followed by a rapid fall, so that in two or three hours the level may fall to 50, or even lower; I have seen the late levels fall to 35. If, however, the patient is brought into the hospital and given an adequate diet for three days the blood sugar curve becomes normal. This emphasizes the importance of nutrition in the symptom complex which develops in about ten per cent of patients following resection. This group are usually nervous and apprehensive, have anorexia, are afraid to eat. In the hospital we can, by the use of casex milk shakes and adequate diet, overcome these symptoms. Great emphasis must be laid on their food intake; they should be on a high protein diet and should eat something every two hours. In this way we can greatly help, if not entirely overcome the problem. Postresected cases who enjoy their food, eat everything in reason, and gain weight, never have these symptoms. For this reason I never limit the diet following resection except to warn against foolish excesses.

DR. FRANK H. LAHEY, Boston, Mass.: Subtotal gastrectomy has, on the whole, been such a satisfactory operation for duodenal ulcer over a period of years adequate to give it a thorough trial, that we must be careful not to relinquish it for one that is as yet really not demonstrated.

Vagotomy in certain cases offers real promise, but with its two as yet undemonstrated effects: (1) loss of motility particularly in patients with duodenal ulcers of an obstructive character; and (2) the uncertainty of the effect of vagotomy done below the diaphragm, we must wait and assess its value carefully before substituting it for the now quite well proven procedures.

We feel very strongly that the technical problem in subtotal gastrectomy for duodenal ulcers is not in the subtotal gastrectomy itself but in the removal of the ulcer. We have repeatedly said that we like to get the duodenal ulcer out because the patient is better off with it out, but particularly because it provides then a good flexible duodenum for safe inversion. Duodenal ulcers so scar, shorten and indurate the duodenum that in many cases if the ulcer is left behind the duodenal closure will be far from a safe and satisfactory one.

Some time ago I suggested that in those cases in which the duodenal ulcer is adherent to the common bile duct, an identifying T-tube be put in the common duct and passed into the duodenum, so that the point of entrance of the common duct into the duodenum and the relation of the ulcer to the common duct could at all times be demonstrated, and that has been, in the very difficult cases, a procedure of real value to us.

I am pleased that Dr. Roscoe Graham has a favorable opinion of the so-called hook-up procedure, the Hofmeister type of subtotal gastrectomy which we have employed over the years. Our Gastro-enterologic Department made a study of this type of anastomosis as compared with the Pólya type of anastomosis, without informing us that they were doing so. They have reported that with the Hofmeister hook-up type of anastomosis, the stomach holds food a much longer time than it does following the Pólya type of resection.

DR. ARTHUR W. ALLEN, Boston, Mass. (closing): Probably it is unnecessary, but I should like to reëmphasize a statement that I have made before, and that is to stick to duodenal ulcer in reporting results for subtotal gastrectomy for duodenal ulcer. We must report gastric ulcer cases separately since the problems are so different.

A point I would like to make is the apparent difference in the results obtained in men and women who have had this operation. Men, although we have a larger percentage of them, are less likely to have late nutritional disturbances than women. We do not know why this is so, but women seem to have more difficulty with diet and maintenance of weight than men.

Doctor Graham's method of exteriorizing of the ulcer penetrating the pancreas is one we have tried. I have had the experience of pancreatic collections that had to be drained after exteriorizing such an ulcer. I have also had a patient develop stenosis of the transpancreatic portion of the bile duct months after operation. I have a feeling that many of these problems can be satisfactorily met if the proper operation is selected for the individual patient.

CONGENITAL HYPERTROPHIC PYLORIC STENOSIS*

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NEW YORK, N. Y.

IN FORMER PAPERS on congenital hypertrophic pyloric stenosis published in 1932 and 1937, I reported a total of 243 consecutive cases operated upon by me at the Babies Hospital in New York with only one death. The purpose of this paper is to bring up to date my personal series of cases at the above hospital, a series which, with the 245 cases upon which I have operated with two deaths since 1937, now comprises 507 cases. We have made no important changes in the treatment, always using the Fredet-Rammstedt operation and emphasizing the immediate preoperative preparation and postoperative care. The success of modern surgical treatment, in which a cure can be permanently and easily achieved by a simple operation continues to prove its superiority over extended medical treatment with its prolonged and uncertain results. With a mortality of 1.8 surgery can be more vigorously recommended than when the mortality was 35 per cent. Parents can now be assured not only that their baby may be operated upon successfully and that he will be retaining all feedings and gaining weight 10 days after operation, but also that he will have no stomach trouble later in life as a result of his pyloric stenosis in infancy.

Etiology.—In spite of the many theories which have been achieved, the etiology is no clearer today than it was in 1887 when Hirschsprung presented two of the earliest cases on record. There are still many phases of the disease and its cure which are unexplained, the chief of these being whether the hypertrophy of the circular muscle precedes or follows the pylorospasm. Others are the occasional spontaneous cure, the disappearance of the tumor about seven weeks after the Fredet-Rammstedt operation, its persistence throughout life in patients who have had posterior gastro-enterostomies, the hypertrophy of the circular muscle coat, the occurrence of the condition about seven times more often in boys than in girls, and its frequency in the first child of a family.

It is our belief that the tumor is congenital in origin, that the pylorospasm follows the hypertrophy and that pylorospasm is responsible for the onset of symptoms between the second and fifth weeks of life. This belief is supported by finding well-marked tumors in each of two premature infants and by the absence of correlation between the size of the tumor and the age at which operation is performed. Fully developed tumors have been found in many babies upon whom we have operated a few days after the onset of symptoms. The variation in the severity of the symptoms seems to be due rather to the amount of pylorospasm present than to the size of

* Read before the American Surgical Association, April 2–4, 1946, Hot Springs, Virginia.

the tumor, since the largest tumor is often present when the onset of the symptoms is least severe.

Pyloric stenosis has occurred in one of twins, the other twin being perfectly normal, and in both babies when the twins were identical. We have found it in all races and nationalities with a slight predominance in the children of Jewish parents, and we have had about two colored babies in each hundred cases. We have not been able to demonstrate a seasonal incidence.

Pathologic Anatomy. — Operative treatment of pyloric stenosis has made it possible to confirm the pathologic findings as described by the earliest writers. The most striking feature is the firm, almost cartilaginous, tumor found at the pylorus. This tumor, which completely encircles the pylorus, is about 3 cm. long and 1.5 cm. in diameter. It is freely movable and projects into the duodenum as the cervix does into the vagina, gradually blending into the pyloric antrum at the gastric end. The term "scirrhous" as applied to this tumor by the earliest writers is quite appropriate. When stimulated, the tumor becomes blanched and firmer in consistency, and when the circular muscle is cut, it is found to be 5–10 mm. in thickness. The stomach is normal except for compensatory hypertrophy and dilatation. Cross-section reveals the lumen of the pylorus almost completely closed and the hypertrophy confined to the circular muscle coat. Microscopic study confirms the site of the hypertropy, and shows all other structures to be normal. The pathologic anatomy in cases of long-standing does not differ from that in cases of short duration except that the stomach is hypertrophied and dilated to a greater degree.

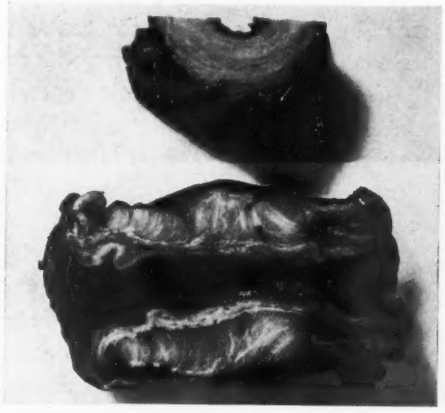

FIG. 1.—Pylorus removed in a patient 29 years of age. Gastro-enterostomy performed in infancy for pyloric stenosis. Pylorus looks much the same as these tumors do in infancy. Microscopic section shows only hypertrophy of the circular muscle coat; width 5 cm.

Clinical Course.—The clinical picture of pyloric stenosis is impressively uniform. Vomiting during or after each feeding is always the first symptom. It may start abruptly, but it usually begins as a regurgitation. The quantity vomited may be small at first, but it increases later, and it may amount to considerably more than the previous feeding due to gastric secretion and to the ever-present gastric retention. The vomiting soon becomes projectile and forceful enough to eject the stomach contents several feet, but it cannot be painful or accompanied by nausea since a complete feeding will often be taken immediately thereafter. The vomitus is never bile-stained, but it may contain mucus and bright blood or coffee-ground material resulting either

from the associated gastritis or from the rupture of a mucosal vessel during the act of vomiting. The baby may lose enough fluid by vomiting to become extremely dehydrated, to lose weight rapidly, to be constipated and to pass only small amounts of concentrated urine.

The course of pyloric stenosis is liable to be rapidly progressive; it is not unusual for these babies to lose from 30 to 50 Gm. in weight daily if the condition is not recognized and treatment instituted. If fluid is not restored, one may expect death from dehydration and starvation in about four weeks' time. Occasionally one sees a baby in whom the progress of the disease is much slower even though the tumor is well defined, and it is in this type of case that medical treatment may be successful.

Diagnosis.—The diagnosis depends entirely upon a history of the course as described and upon palpation of the pyloric tumor which is present in every true case, and which is pathognomonic, being found in no other condition. Gastric peristaltic waves, although always present, their intensity depending upon the duration of the obstruction, cannot be considered diagnostic since they occur in other conditions. The waves start at the left costal margin and pass across the epigastrium toward the right side. It is not unusual to see a second wave start before the first has completely disappeared. In a long-standing case, in which there has been a considerable loss of weight, the waves are easily seen, and the outline of the full stomach is sometimes evident through the thin abdominal wall. While waves are most obvious after the baby has had a feeding or when the stomach is full, the tumor is felt most easily when the stomach is empty and the baby is relaxed with a sugar pacifier. As we believe that the tumor can be felt in every case, we do not operate until it has been felt. If some such rule is not established, many patients will be operated upon who do not have pyloric tumors. The tumor, which feels like a small olive, is found most frequently in the right upper quadrant to the right of the lateral border of the rectus muscle and about 4 cm. above the umbilicus. If the tumor lies beneath the liver or the right rectus muscle, it is difficult to feel, and a bulge of rectus muscle between the linea transversa may be mistaken for it, particularly if the abdomen is not well relaxed. If one presses the fundus of the stomach toward the midline with the left hand while palpating for the tumor with the right hand, many tumors will be brought out where they can be felt easily. The tumor may often be found at the point over the right epigastrium where the peristaltic wave disappears. It is in many instances surprisingly superficial. Although diagnosis may be made roentgenologically, we believe this to be not only unnecessary but actually contraindicated since it greatly increases the baby's postoperative discomfort if all the medium is not removed.

Preoperative Treatment.—Restoration of the fluid lost by vomiting before operation is, without doubt, the most important factor in the present low surgical mortality. This operation should never be considered an emergency, and no baby should be operated upon until he is completely hydrated. It is perfectly safe and often necessary to spend several days

in preparing a baby for operation. Because many of these babies have alkalosis with a chloride deficiency, saline should be supplied in generous quantities. Hypodermoclyses consisting of about 80 cc. of physiologic salt solution with or without dissolved glucose should be given twice a day until hydration is complete and this point may be determined by clinical observation rather than by laboratory tests. Transfusion of blood and intravenous fluids are practically never necessary. During the days of preparation, the baby should be given 60 cc. of 5 per cent glucose by mouth every three hours since he retains this better than a formula feeding.

Immediate Preoperative Care.—Three points in the immediate preoperative care which contribute materially to the success of the operation are worth emphasizing. Open drop-ether is the anesthetic of choice since it is well tolerated by these small babies. Novocaine may be used for local infiltration or field block, but we believe that it makes the operation more difficult, not only for the patient, but also for the surgeon; and it sometimes interferes with proper wound healing. Body heat may be maintained during operation by placing a half-filled hot-water bottle beneath the baby on the operating table. It is much easier to handle the stomach during operation, and the chance of opening the duodenum is decreased, if the stomach is emptied with a tube immediately before the incision is made.

Operation.—The Fredet-Rammstedt operation is used in all cases because it is simple to execute, and it gives a permanent result. Its purpose is to relieve the obstruction at the pylorus by incising the circular muscle and spreading the cut-muscle surfaces until the mucosa completely fills the incision. Tincture of merthiolate is used to paint the skin, and a 6-cm. right rectus incision is made, starting 1 cm. below and to the right of the xiphoid cartilage. In order to deliver the pylorus into this high incision, the liver has to be retracted upward. The pylorus is delivered into the incision and the tumor held between the left index finger and the left thumb, is incised over its entire length beginning at the pyloric vein and passing upward. Only the superficial part of the tumor should be cut with the scalpel, and the incision should not be made too near the duodenal end because of the danger of perforating the mucous membrane. The cut-muscle edges are spread with a mosquito forceps beginning at the stomach end of the incision until the mucosa bulges sufficiently to completely fill the incision. The pylorus is dropped back into the abdomen and allowed to remain undisturbed while the parietal peritoneum is picked up with forceps preparatory to the closure of the abdomen. The tumor is then exposed in the abdomen to be sure that it is not bleeding. The liver, after release of the retractors, usually walls the peritoneal incision off from the rest of the abdominal cavity, thus, practically insuring against wound evisceration. To close the abdomen, we use continuous chromic in the peritoneum and anterior rectus sheath, and Michel clips in the skin. A small dry dressing is applied with adhesive straps. The clips are removed on the third or fourth day. After having tried fine silk closures, which would seem ideal for these incisions, we have

returned to the use of chromic catgut because of the great nuisance of removing the silk knots which may be quite troublesome even when the finest material is used.

Postoperative Treatment.—After operation, the baby is taken immediately to the "Pyloric Room" where the temperature is kept constant and from which all visitors are excluded. These infants in particular must be protected from all sources of infection because of their low resistance.

Each patient receives a clysis of saline and glucose once a day for the first three days after operation. The formula is increased until the baby is receiving 30 cc. every three hours at the end of 24 hours. All feedings for the first five days are given with a medicine dropper; the head of the bed is usually elevated to about 20° at feeding times, but the infant is not picked up. If the baby is to be breast fed, he is nursed once on the fifth day, twice on the sixth, *etc.*, until completely breast fed. Breast-fed babies are discharged from the hospital on the tenth postoperative day, while formula-fed babies are discharged on the fourteenth day after operation.

Complications.—It is unusual for a pyloric baby to have anything but the most uncomplicated convalescence. If the stomach has been properly emptied in the operating room and the operation correctly done, these babies do not vomit. If vomiting occurs, emptying the stomach with a tube will usually be all that is necessary. Postoperative respiratory infections are almost unheard of. One baby in this series developed an aspiration pneumonia just as he was ready for operation, but he was operated upon successfully under local anesthesia. One patient developed a duodenal obstruction from adhesions six weeks after operation, but was completely relieved by freeing the adhesions. The duodenum was inadvertently opened twice in this series, but in neither case was the convalescence affected. There has been one wound evisceration in this group but convalescence was uninterrupted after resuturing of the incision. We have had no severe wound infections and no known incisional herniae.

Healing after Fredet-Rammstedt Operation.—Dr. Martha Wollstein has made a study of healing after the Fredet-Rammstedt operation based upon a study of material from twenty-three autopsies performed from 24 hours to two years after operation. A brief summary of the important points of that study follows:

After the Fredet-Rammstedt operation, healing is brought about by cells of the serosa and submucosa, but the unstriped muscle cells take no part in the process. The incision in the pylorus is healed in nine days. The pylorus has become relaxed within two weeks. The stomach has returned to normal size within a month and the gap between the cut ends of the muscle coats has practically disappeared in six weeks. In two years only a thin line of connective tissue fibers separates these two muscle ends and the stomach is quite normal. In contrast to the operation of gastro-enterostomy which leaves the pylorus unchanged, the Fredet-Rammstedt operation cures the pylorus lesion.

Follow-up.—We have been able to follow 82 per cent of our cases. The two deaths in this series of 245 cases (1937–1946) may be briefly summarized as follows:

The baby died one month after operation from enteritis from which he was suffering at the time of operation. After operation, his vomiting ceased, but his diarrhea continued until his death. At autopsy, the Fredet-Rammstedt operation was well healed, but a severe enteritis was present, the cause of which was undetermined. He also had multiple congenital anomalies. The second baby died very suddenly 12 hours after operation. The only relevant contributing cause was a very stormy anesthetic with difficult and prolonged induction. No autopsy was obtained.

I have operated upon two patients, 29 years of age, who had had gastro-enterostomies performed at the age of six weeks for pyloric stenosis. In both patients, the pyloric tumor was present, looking exactly as it does in infancy. Microscopic study of one of these tumors showed that the only abnormal finding was hypertrophy of the circular muscle coat.

SUMMARY

1. Congenital hypertrophic pyloric stenosis occurs about seven times more often in boys than in girls.

2. Vomiting is always the first symptom and in the majority of the cases begins between the second and the fifth week of life.

3. The tumor, caused by hypertrophy of the circular muscle of the pylorus, is pathognomonic of the condition and may be felt in every case.

4. The Fredet-Rammstedt submucous pyloroplasty is the most satisfactory operation and gives a permanent result, as shown by the follow-up of the cases reported.

5. Preoperative preparation is the greatest factor in bringing the mortality to its present level.

6. The tumor disappears in about seven weeks after the Fredet-Rammstedt operation but persists throughout life in those cases who have had a posterior gastro-enterostomy done.

7. Results in 507 consecutive cases are reported.

TABLE I

No.	Deaths	Mort. %
1932—119	7	5.9%
(100)	(1)	
1937—143	0	0
1946—245	2	0.8%
Total 507	9	1.8%

TABLE II

M.	F.	Deaths	Mort. %
1946—206	39	2	.81%
Only Child	White	Colored	F.U.
130	241	4	82%

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DISCUSSION.—DR. WILLIAM E. LADD, Boston, Mass.: I think Doctor Donovan should be congratulated on his paper and results. His ideas so closely coincide with mine that it is rather difficult to discuss his paper. Recently we have analyzed our records, and I think a report may be of interest. This analysis differs from Doctor Donovan's in the fact that it goes back many years further, and includes cases operated upon by all the surgical staff of Children's Hospital, including the resident staff, from 1915 to 1946, a period of 30 years. In that time we have had 1,145 cases. In the first 20 years, 1915 to 1935, there were 588 cases, with 35 deaths, a mortality of 5.9 per cent. In the last ten years there were 557 cases, with five deaths, a mortality of 0.8 of one per cent. In the last three and one-half years, there have been 225 consecutive cases with no deaths.

Of the five deaths in the last ten-year period, four had postmortem examinations. The causes of death were as follows: The first, aspiration pneumonia; the second was a questionable Mongolian idiot with defects of the central nervous system, kidneys and ureter; the third, pulmonary edema and terminal pneumonia. (I think this was possibly due to giving too much fluid. One should be cautious about not giving too much parenteral fluid to these small babies.) The fourth case died apparently of intestinal obstruction from congenital stenosis of the ileum which was not recognized at the time of the operation for pyloric stenosis.

I want to congratulate Doctor Donovan on the incision. We had more trouble with wounds in the first part of our series than he did. We had a few eviscerations and a certain number of cases in which the wound broke down. That may have been due to faulty technic, but I am inclined to think it was due more to the fact that in the early period we received these patients in very emaciated condition, extremely dehydrated, with extremely low resistance. We used the right rectus incision, and catgut for sutures. When we had trouble with the wounds we shifted to silk, and still had just as much trouble. More recently, we have come to the high transverse gridiron incision, and have gone back to silk. This incision gives a very good exposure and, with that and the use of silk, we have had no trouble with the wounds. I will not say that we have not had an occasional stitch that has spit-out, but not

enough to be embarrassing—and I am very easily embarrassed. I loathe having wounds spit-out stitches for any length of time.

I would put the importance of results in this order: First, recognition by the pediatrician that pyloric stenosis is a surgical condition. As long as there are no pediatricians here, I might say it took them an extremely long time to discover that. Second, recognition by the surgeon that this is not an emergency operation. I think this is extremely important. I can remember the time when we did consider it an emergency, and the worse the patient's condition the more emergent we considered it to be. Now, the worse the condition of the patient the longer we take to prepare him for operation. The third item is improvement in surgical technic and the avoidance of mistakes, which I have made and which I think most of us have made.

Dr. Edwin M. Miller, Chicago, Ill.: I feel almost like apologizing for making any remarks, in view of the large series of cases reported by Doctor Donovan and that commented on by Doctor Ladd. However, in my personal series of 67 Ramstedt operations there have occurred several interesting things, a few of which are worthy of mention.

In making a diagnosis there is one condition which may simulate very closely the clinical picture of pyloric stenosis: *i. e.,* congenital atresia of the first part of the duodenum. Ordinarily, of course, such an anomaly occurs below the ampulla of Vater and, therefore, the vomiting of bile is a differentiating point, but occasionally one sees the atresia close to the pylorus. One of my earliest cases (1921) was of this type. The diagnosis of pyloric stenosis had been made by a prominent pediatrician in spite of the early onset of vomiting, but at operation I found a normal pylorus and side-tracked the atresia by a posterior gastro-enterostomy. That little infant (weighing about five pounds) is now a healthy young lady who recently graduated from high school.

In my series one infant was premature (seven months); another was unusual in that three months time had elapsed between birth and the onset of symptoms of pyloric obstruction. A large tumor was found at operation and the postoperative course was excellent.

We differ a little from Doctor Donovan in choice of anesthesia, finding local anesthesia very satisfactory in the vast majority of cases. In 1930 an unusual complication arose which deserves a word. The infant did well following operation for nine days, gaining weight and taking food well, but suddenly a complete block apparently occurred at the pylorus, with projectile vomiting, rapid loss of weight, and marked dehydration. I considered exposing the site of the Ramstedt procedure, but finally changed my mind, entered the abdomen on the left side and performed a posterior gastro-enterostomy. The accompanying two lantern slides show (1) the emaciated appearance of the baby just after the second operation; and (2) the plump, well-nourished infant seven weeks later, and testify to the wisdom of the procedure adopted.

Dr. Edward J. Donovan, New York City (closing): There was one baby in the earlier series that I reported, upon whom a Fredet-Ramstedt operation was done, but she continued to vomit. We were able to treat her conservatively for four weeks because she was not losing weight. I then did a posterior gastro-enterostomy, with complete relief of the vomiting. At the second operation the Fredet-Ramstedt incision looked perfect, but we did a gastro-enterostomy because we suspected that some other condition existed such as a duodenal membrane which was neither visible or palpable at the time. She has remained well for several years. I wish to thank Doctor Ladd and Doctor Miller for their discussion of my paper.

LATE RESULTS IN THE TREATMENT OF ULCERATIVE COLITIS*

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IN ORDER to determine the advisability of continuing radical surgery in the treatment of ulcerative colitis it seems wise at this time to review and to evaluate our late results. In previous communications, morbidity, immediate mortality and early results have been discussed. Many interested in this field of surgery have frequently asked what has become of these colectomized individuals after five years.

During the past ten years at the Roosevelt Hospital, we have operated upon 97 individuals with this disease; four others were operated upon in other hospitals, making a total of 101. Within the past few months I have been able to see personally, question and examine 50 of the 80 patients who survived operation and who could be reached for interview.

Following is a distribution of the cases according to the length of time since they were operated upon (Table I):

TABLE I

DISTRIBUTION OF CASES ACCORDING TO TIME SINCE OPERATION

3 operated upon	10 years ago
6 operated upon	9 years ago
4 operated upon	8 years ago
3 operated upon	7 years ago
5 operated upon	6 years ago
3 operated upon	5 years ago
7 operated upon	4 years ago
8 operated upon	3 years ago
8 operated upon	2 years ago
3 operated upon	1 year ago

Although the study of 50 of these patients is not a large number, there is much of importance which we have learned from this follow-up.

The most significant and encouraging fact as regards radical surgical management, in my opinion, is that 95 per cent of those individuals have gained considerable weight, are relieved of annoying bloody diarrhea and are afebrile. They have gained from 40 to 50 pounds following ileostomy and they have continued on in gaining weight up to as much as 120 pounds following removal of their colons. The average amount of weight-gain for these 50 patients is 45 pounds. There has been one striking exception in a woman of 34 to whom we gave an ileostomy and subsequently removed her entire colon and her rectum. At no time following those three procedures, nor at the present time (eight years later), has she been able to gain much weight. The over-all gain in weight has been only 16 pounds.

* Read before the American Surgical Association, April 2–4, 1946, Hot Springs, Virginia.

Coincident with the considerable gain in weight there has been a feeling of well-being and a remarkable mental adaptability to the nuisance of ileostomy. In questioning these patients carefully we have found them relatively content with going on with ileostomy rather than taking the chance of ascending small bowel involvement with fatal outcome (of which there is a possibility), if the ileostomy is taken down and the fecal stream restored by joining it to the upper rectal segment which has remained. Many state that they have become quite used to handling the ileal flow, both day and night. There have been no suicides in the 80 patients who have survived the operation, as far as I can learn.

In two individuals we have been able to successfully take down the ileostomy and restore the fecal stream by ileosigmoidostomy. A man, age 21, had been given ileostomy; two years later, colectomy; three years later the ileostomy was taken down, with complete reëstablishment of the fecal stream. The remaining segment of lower sigmoid and rectum had completely healed. This man made an uneventful recovery, has gained 30 pounds in weight and is perfectly well. He has two bowel movements each day, well-formed and normal in every particular. Another man, age 22, was subjected to ileostomy two years ago, colectomy one year ago; and four months ago the ileostomy was taken down and ileosigmoidostomy, side-to-side was performed. In this early follow-up the patient seems well, has gained some weight. He did have, however, a distressing diarrhea, with six to eight bowel movements a day for one month following restoration of the fecal current.

An annoying, frequent and, at times, serious complication is prolapse of the ileostomy. This has often caused a sudden obstruction to the ileal flow, either temporary or persistent. In many instances ileostomy revision had to be carried out, principally to relieve obstruction, or to prevent gangrene of the protruding intestine. However, occasionally for the reason that the stoma protruded so far and hung down to such a degree that it became disabling. We have attempted in every way to overcome this threat to the individual. We have sutured the rent in the mesentery with great care to the undersurface of the anterior abdominal wall. We have sutured as much as possible of the fatty mesentery of the ileum to the peritoneum; we have turned down a flange of serosa around the entire circumference of the ileum and sutured this to the peritoneum; even with the finest needles and suture materials; small pinpoint openings resulted through which the fluid ileal contents seeped out and escaped down the surfaces of the thigh, especially at night. In my opinion, this problem of frequent prolapse of the ileum has not been solved, and remains an unpredictable and serious complication. In one instance, nine years after ileostomy and colectomy, we have had an amazing ten-inch prolapse of the mucous fistula of the upper end of the distal divided rectal segment through the anterior abdominal wall. We have had no difficulty whatsoever from retraction of the ileal stoma back into the abdominal cavity.

Of the 38 individuals in this series with ileostomies there were 11 who

had real difficulty with prolapse; troublesome because frequently it was reduced after many hours of strenuous effort. Five of these 11, almost 50 per cent, came to revision on account of obstruction.

Aside from prolapse of the ileostomy, the greatest problem for these patients to solve is prevention of irritation of the skin around the ileal stoma. In this recent follow-up, we have tried to learn the best method of avoiding excoriation. It has been rather discouraging to determine just what is the most effective material to use on the skin.

Eleven of this group of 50 had ileosigmoidostomy and, therefore, did not have skin aggravation to contend with; one had been given transverse colostomy and had no irritation. Of the remaining 38, 19 had no trouble from skin vexation; eight had slight or moderate excoriation and the remaining 11 suffered considerably from this constant burning annoyance. All of the 19 patients, devoid of any irritation, used Fuller's earth or some dry dusting powder. The eight where there was slight or moderate irritation had occasionally used ointments. In the remaining 11, where there was marked irritation, all used some sort of greasy application, either zinc oxide ointment, aluminum paste or vaseline.

In view of these findings, we believe that the best and most satisfactory application to the skin is a dry dusting powder or Fuller's earth (kaolin). The skin should be bathed once or twice a day with soap and warm water and the powder or kaolin freely applied.

A never-ceasing worry is acute or intermittent ileus due to adhesions or volvulus at or near the ileostomy opening. Four patients were operated upon, adhesions were freed, the obstruction relieved; two had a volvulus about the ileum and in one the ileostomy had to be moved from the right to left lower quadrant due to two episodes of obstruction from volvulus.

Even after five years intermittent blocking of the lumen of ileum is relieved by a catheter inserted into the stoma followed by gentle irrigation.

There have been three striking instances of repeated collapse from sudden salt deprivation, on account of unexplainable abrupt and profuse diarrhea through the ileal stoma. During these episodes, the patients seem exhausted, prostrated, hollow-eyed and apprehensive. They are so fearful of these sudden relapses, that they carry with them, at all times, salt tablets. One man, a policeman who now weighs 225 pounds, experiences such an attack about once a month. He is aware of the oncoming attack and now has learned to immediately enter a hospital where he is given large doses of intravenous saline which forestalls the collapse.

All patients, at all times, are encouraged to use an abundant amount of salt in their food, in order to maintain a high sodium chloride blood level and, thus, avoid these distressing setbacks.

In approximately ten per cent of all people suffering from nonspecific ulcerative colitis the sigmoid and rectum are free of the disease. The cecum, ascending, transverse and occasionally the descending colon are involved; these patients, on the whole, are less desperately ill than those where

the disease starts in the rectum. They respond quickly and permanently to "by-passing" the fecal stream through ileum to sigmoid anastomosis.

We have performed primary ileosigmoidostomy in 11 cases. One of these patients progressed satisfactorily for a period of five years, when suddenly she started up with a profuse diarrhea, with blood, pus and mucus. She rapidly lost weight. Barium enema revealed that the ileum attached to the remaining sigmoid showed ulcerations for a distance of a foot and a half proximal to the anastomosis. It was deemed advisable to immediately take down her ileosigmoidostomy; we resected a secondarily involved ileum and gave her an ileostomy. Since that time she has been perfectly well, for a period of five years. Her lower sigmoid, colon and rectum have been left in. We had a further experience with a young woman, age 23, who had been given an ileostomy; her colon had been removed, and two years later she rapidly went downhill. The disease involved the ileum; four feet were resected; she continued with a severe involvement further up in the small bowel and finally succumbed.

It has come to our attention that four of our younger female patients have become pregnant. All four had ileostomies and their colons removed. We were fearful of what would happen to the ileal stoma and to the mucous fistula of the divided lower sigmoid segment, if the pregnancies were allowed to proceed. Therapeutic abortions were thought advisable and were carried out by the patients' obstetrician, after consultation.

We have found that practically all of the patients, who have been colectomized after ileostomy and retained their rectal pouch, have a fair amount of discharge through the anal opening two or three times a day, some only once a day and others once every other day. They describe these discharges as composed principally of mucus, usually light brown in color, occasionally streaked with blood.

Where the discharge is annoying and is of foul odor, a rectal lavage biweekly has proven helpful.

Incidentally, a few of these patients, when nervously or mentally upset complain of spasm in the remaining rectal pouch and in increased amount of discharge. One man, a Professor at a girls' college, whose colon we removed after ileostomy, found that when he went into the library where there were no toilet facilities for men he became very nervous, apprehensive, with severe pain in his lower pelvis and at the anal opening, spasm-like in character, and if he got too far into the library, he would immediately have to leave and would have frequent bloody discharges for the next six or eight hours thereafter—a striking example of psychosomatic medicine.

In this recent study of the late results an attempt has been made to determine if there is any standard diet that could be formulated whereby a patient could be assured of minimum discharge from the ileostomy opening. We have questioned closely these individuals who have had ileostomy from five to ten years, to see if they could suggest a diet which would be helpful. We have been absolutely unable to come to any conclusion as to what is the

most suitable diet for all patients with ileostomy. All of these people will tell you that they eat practically everything, except spinach, uncooked fruit; they cannot drink fruit juices, but they can drink in moderation, alcoholic beverages. Many of these patients who are allergic to milk, orange juice and eggs prior to operation find that since ileostomy and even colectomy, they still are upset when they try to include these articles in their diet. Surgeons throughout the country are continually writing in to find out if there is a standard diet that can be suggested to these patients. The answer is no; it is purely a matter of individualization. In general, we can say, that most of the individuals thrive on a full, regular diet except for minor idiosyncrasies.

All of these 50 patients were interrogated as to their present employment status. Forty were at work. The men had resumed their jobs or had gotten new ones; a few were laborers, insurance agents, a bank clerk, detective, dentist, real estate agents, *etc.* The women who had been housewives, after not too many months, had resumed full activity in keeping their homes in order and doing their usual chores of housekeeping.

It is surprising how little mechanical annoyance the ileostomy bag has proven to be. Many of the younger patients are able to play golf, baseball, some play tennis and a few even swim in the ocean.

In this group of 101 patients who were operated upon, there were three who showed malignant changes, originating in a polypus in some part of the colon. These three patients are still alive, one seven years, one five years and the other three years, after colectomy. Another patient developed a carcinoma in the remaining rectal segment, failed to notify her physician of persistent bleeding over two years time, and returned to our hospital to find the lesion inoperable. She succumbed to this malignant tumor.

L. D. Whittaker,[3] in 1937, reviewed 40 colectomized individuals who had been given an ileostomy and their colons and rectums had been removed. He found that after a period of about three months it was not necessary for the ileostomy bag to be changed at night, and he observed that the ileum assumed a function of the colon and enlarged after removal of the entire colon and especially the rectum; there was no marked disturbance in mineral metabolism; and that after ileostomy the chlorides and the blood plasma and serum calcium were only temporarily reduced. In other words, the ileal stoma and its adjacent segment seemed, in part, to take on some of the characteristics and function of the rectum, after prostatectomy. In our own series 11 rectums were removed following ileostomy and colectomy. In seven of these cases there was a noticeable thickening of the ileal contents and all of these patients had less difficulty at night.

Furthermore, three of the younger age-group who, due to the severity of the disease, showed lack of skeletal development prior to diversion of the cecal flow, present some improvement since. Removal of the large bowel and rectum, with ileostomy for many years, has not retarded or hindered, the normal development of the muscular, cardiovascular, skeleton or hema-

topoietic symptoms to any degree, as far as can be determined by known clinical and laboratory methods. Personality defects exist and, assuredly, can be expected on account of the constant annoyance of a flowing ileal opening.

Up to the present time the sulfonamides, except perhaps for sulfathalidine, have been disappointing in the treatment of chronic intractable ulcerative colitis. Penicillin has been proven of no value. In a personal communication with Dr. Chester Keefer,[4] of Boston, I learn that although streptomycin was tried in a considerable number of patients in the army that it, too, was valueless.

Therefore, it seems to me that radical surgical measures are the only means of offering these people, when they have reached the chronic intractable stage, any hope.

In conclusion, I should like to state that of all sick people I know of no group who require more encouragement, attention and morale support from the surgeon who operated upon them; than those who suffer from ulcerative colitis, especially in the first year of ileostomy.

SUMMARY

In the past ten years 101 patients with intractable ulcerative colitis have been operated upon. There were 20 immediate or early fatalities. Of the 80 survivors, 50 have been seen in the past few weeks and examined by the essayist.

The average gain in weight of these 50 patients was 45 pounds.

There was found to be a surprising adaptability in the care of the ileostomy.

The fecal stream has been successfully reëstablished in two patients by ileosigmoidostomy.

Prolapse of the ileum through the stoma has been a frequently disabling and serious complication. I am unable to make any constructive suggestions to avoid it.

To prevent irritation of the skin about the ileal stoma, compound tincture of benzoin, followed by generous applications of Fuller's earth, or a dusting powder of some sort, is generally effective.

Acute ileus due to adhesions or a volvulus is not an infrequent occurrence.

Sudden collapse from salt deprivation is treated by administration of large amounts of salt orally and intravenously.

In female patients who became pregnant, therapeutic abortion, after consultation, is warranted.

There is no standard diet for all patients with ileostomy. Fruit juices and leafy vegetables should be avoided.

Frequently, following the removal of the rectum as the third and final stage in the surgical treatment of this disease, the ileostomy takes on, in some degree, the functions of the rectum; the ileal contents become more solid; the lumen appears to enlarge; and the walls thicken.

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DISCUSSION.—DR. RICHARD B. CATTELL, Boston, Mass.: Doctor Cave has made a valuable contribution in presenting his experience in the treatment of ulcerative colitis. It is essential to have reports such as his to evaluate the surgical treatment of this condition. There has been criticism of the extensive surgical procedures necessary to cure ulcerative colitis and it should be stated that the only patients submitted to operation are those who cannot be managed by medical means.

Doctor Cave has been frank in presenting the postoperative complications and we must report a similar experience. We have reduced the incidence of ileal prolapse by careful anchorage of the mesentery of the ileum to the underside of the abdominal wall and by closure of the peritoneum between the ileum aand the lateral abdominal wall.

I should like to report our experience with ulcerative colitis for a similar ten-year period, 1932–1941. Eighty-three ileostomies were performed, with 12 deaths, an operative mortality of 14.5 per cent. Thirty-nine total colectomies, all of which included removal of the rectum, were carried out, as well as 15 partial or segmental colectomies. During this ten-year period, 103 patients had 226 operations, with a patient mortality of 20 per cent and an operative mortality of 9.3 per cent. Our experience has again demonstrated the seriousness of the surgical treatment of ulcerative colitis which must necessarily be carried out on poor risk patients.

If we are justified in submitting patients to ileostomy and colectomy, we must make the life of the patient our personal responsibility. The problem of skin irritation is not so great as it was ten years ago. The Rutzen bag which can be cemented to the skin has been found very satisfactory and is a practical means of avoiding all irritation of the abdominal wall. The patient who has been under our observation for the longest period since total colectomy was performed was operated upon 14 years ago. She leads a normal life and is able to undertake all the activities she carried out before operation.

DR. HARVEY B. STONE, Baltimore, Md.: With some diffidence I would like to present a procedure I have used several times in an attempt to overcome the difficulty of marked prolapse of the ileal end through the stoma. Assuming this is the original incision with the protrusion of the ileal end, a second incision is made lateral to the first, the bowel just above the stoma is folded upon itself into a U-shaped plication, the two adjacent arms are sutured, incised in a U-shaped manner, then the U-shaped closure done as in pyloroplasty. The two arms remain adherent to each other and there is a stoma between the two lumens. That may do two things; first, it forms a bulky mass immediately above the ileostomy, which mechanically opposes difficulty to the intussusception of the intestine through the open end of the ileum; second, it forms a reservoir in which there is a temporary stasis of the liquid contents of the ileum, and perhaps a period of longer absorption and a dryer stool. It has worked in the cases in which we have tried it.

DR. JAMES D. RIVES, New Orleans, La.: In a very limited experience with this disease, I have made one observation which I think is certainly interesting and possibly significant. I think all those who perform ileostomies are faced with the question

by the patient as to whether or not it would be permanent or whether the continuity of the bowel can ultimately be restored. I have observed two groups of cases from a clinical standpoint, both small and of no statistical significance. One group consists entirely of women. In these cases when the bowel was exposed at operation it appeared grossly normal, thickening was minimal and, if we had not had roentgenologic studies prior to operation we would have doubted that extensive disease existed. After the bowel was excised the inflammatory process was found to be limited to the mucosa and submucosa, with a moderate amount of edema in the outer coats. While these patients improved in nutrition after ileostomy, they continued to have a blood and mucus discharge from the rectum, even when only the terminal sigmoid and rectum were left. The loss of blood was sufficient to cause continued secondary anemia. In each of these cases total colectomy was required, even though in one case there was total defunctionization for about five years.

The other group consists entirely of men. The bowel when exposed was extremely thick and red, frequently showing white stippling that, against the red background, gave the appearance of a strawberry. It was practically identical with the gross pathologic picture of subacute regional enteritis. In these patients not only did the nutritional state improve after operation, but the diarrhea ceased completely before the period of dehydration that follows ileostomy had been overcome. One man gained 50 pounds in 60 days, and was completely relieved of all symptoms except those incident to the ileostomy. One, I closed too soon and, as a result of complications, he died; another, still has the ileostomy but is completely free of symptoms and is now working as a flight instructor. Another, after two years showed no evidence of disease, no blood in the stool, and the ileostomy was closed. He has been free of symptoms for more than a year and appears to be cured.

The fact that those cases showing the least pathologic change in the bowel will respond poorly to defunctionalization, and that those showing the most marked pathologic changes tend to recover completely under the same regimen, suggests the possibility that they might be two entirely different diseases, although the microscopic picture in the two types differs only in degree. Whether or not these are coincidences I do not know, but it would be of value if others who see more cases than I do should prove or disprove this assumption.

DR. DERYL HART, Durham, N. C.: In a limited number of our cases of ileostomy the prolapsed ileum has been anchored within the peritoneal cavity by a relatively simple procedure which has given complete relief from the prolapse. The mesentery of the terminal ileum is laid out over the posterior peritoneum in the right iliac fossa as an open fan, with the terminal ileum coming across the pelvis from left to right and extending up and out through the ileostomy opening. The mesentery is then anchored to the posterior peritoneum with mattress sutures of silk, taking care to avoid injury to the blood vessels. As one passed further from the ileostomy, the anchoring sutures were placed further and further from the intestine, giving increasing mobility at greater distance from the ileostomy. With the ileum thus anchored, prolapse is impossible.

There are two evident dangers which must be guarded against. The first is kinking of the ileum with obstruction. In addition to bringing it in along a broad arc to the ileostomy opening, a rubber tube may be left in. Also, the course of the intestine may be noted for ease of reinsertion in case the tube comes out. The second danger is leaving a band of anchored mesentery beneath which an unanchored loop of intestine may slip, with a resultant obstruction. This is guarded against by the method of anchoring the mesentery and by closing completely the space between the ileostomy and the right abdominal wall.

Perineal wounds left from the combined abdominoperineal resection heal slowly, probably because of the character of the infection. One of our patients who received

little benefit following an ileostomy and later a colectomy except for the rectum had the rectum excised despite the most extensive dissecting infection extending through the perineum and out onto the buttocks and the labia majora. She stood the operative procedure well but continued to run a daily temperature elevation, and the infection continued to spread despite every care that could be given by the staff, including the bacteriologists and mycologists. The spread beneath the skin with multiple perforations and bridges of skin left resembled in some respects the appearance seen in advanced disease in the colon. No specific types of organisms could be identified with certainty as to its etiologic significance. Many treatments were tried including those for anaerobic infections.

After a period of two years, during which she was kept alive only with the greatest effort on the part of the staff, penicillin became available, but only for patients suffering from very serious and acute illnesses. One of the interns developed a method of salvaging the penicillin from the urine of those eligible to receive it, and applied this salvaged penicillin as compresses to the surface wounds. The improvement was immediate and nothing short of miraculous. The wounds cleared-up and skin could be grafted without difficulty. The only setbacks occurred when the supply of reclaimed penicillin was exhausted, due to the lack of patients eligible to be treated with the restricted civilian supply. From this we had hopes that ulcerative colitis might respond to penicillin therapy, but subsequent results have not borne this out.

Dr. Frank R. Peterson, Iowa City, Iowa: I should like to make the comment that three of our women patients who have had colectomies have become pregnant, have carried their babies to term, delivered normal babies and had no difficulty so far as bowel function was concerned during the pregnancy.

Dr. Henry W. Cave, New York City (closing): I wish to thank you for this generous discussion. I have tried the suggestion of Doctor Cattell in closing off the right side in order to prevent prolapse, but have been unsuccessful. I have never made an attempt to suture the mesentery lower down in the pelvis as described by Doctor Hart. I should think that this would prove to have real possibilities. It seems to me that Doctor Stone's method, as he described it here, would most assuredly prevent a prolapse and I think it should be tried more often by the various surgeons interested in this problem. Doctor Peterson's statement is very interesting—three patients with ileostomies and colons removed who delivered normal babies. My statement in regard to this I think should be restated: "We were fearful, no doubt an unfounded fear, of what would happen to the ileal stoma and to the mucous fistula of the divided lower sigmoid segment, if the pregnancies were allowed to proceed."

Doctor Cattell has mentioned the use of the Rutzen bag and, although I have not used this bag except in one or two instances, I think it is the best one so far on the market, and I do believe it will more surely solve the problem of excoriation than anything else we have tried.

DIVERTICULITIS OF THE COLON*

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DIVERTICULITIS, a many-sided condition, is of interest to physicians, surgeons, pathologists, gynecologists and urologists. It can be conveniently discussed under the following headings:

1. Diverticulosis.
2. Diverticulitis with spasm.
3. Diverticulitis with complications:
   - (a) Perforation.
   - (b) Sinus and fistula.
   - (c) Obstruction.
   - (d) Complicating or masking other disease.

DIVERTICULOSIS

Diverticulosis is the term given by Case[1] to describe the findings of multiple diverticula in a routine radiographic picture of the large bowel. By definition, it is not supposed to be of any significance — an incidental discovery which it is well to record. The patient has no symptoms referable to the diverticula and the bowel peristaltic pattern is not upset in any way. Diverticula of the descending colon and sigmoid were recorded in over 5 per cent of postmortem examinations in persons of 40 years, and over, at the Mayo Clinic;[5] and almost the same figures were given for roentgenologic examinations during life by the Mayo Clinic,[6] and by Jones,[3] of Cleveland. In the University of Rochester hospitals we have recorded diverticulosis in only 27 persons by roentgenologic examination. This roentgenologic diagnosis is apparently not reported regularly in our record room. These patients had no symptoms referable to the colon and sigmoid. Nevertheless, a listing of diverticulosis had to be changed later to diverticulitis because an inflammation occurred in some of these pouches. The reverse picture was seen where, at postmortem examination, diverticulosis was diagnosed but during life the individual had repeated attacks of diverticulitis. The recovery from the inflammation had been so perfect that no trace of previous trouble remained. We have had 553 cases of diverticulosis registered in our autopsy files of 8,500 postmortem examinations. If these were corrected for age it is certain that the incidence of diverticulosis would be high in the 40-year plus group.

* Read before the American Surgical Association, April 2–4, 1946, Hot Springs, Virginia.

DIVERTICULITIS WITH SPASM

Diverticulitis with spasm can be diagnosed by symptoms, by roentgenologic examination, by a combination of these two (the most satisfactory method), sometimes by proctoscopic examination,[2] by exploration, and by postmortem study. The majority of cases of diverticulitis are those with spasm. In the University of Rochester hospitals we have diagnosed diverticulitis with spasm 111 times. In 81 of these patients there were typical clinical histories and physical examination findings backed up by roentgenologic evidence of multiple diverticula with irritation and spasm of the large bowel. In 24 instances the history and physical examinations were so outstanding that no reasonable doubt could remain as to the correctness of the diagnosis without roentgenologic examination. In some of these cases the patient was considered to be too ill for barium enema examination, and it was not done. In others, it was done sometime after the acute symptoms had subsided and although diverticula were shown, no spasm was demonstrated by roentgenograms. Occasionally such examination was attempted during the attack but was unsatisfactory because of poor retention of the barium or poor preparation of the bowel for examination. In two cases the roentgenograms were characteristic of diverticulitis with spasm but the patient did not register any symptoms and very little was found on physical examination. In eight cases exploration revealed that diverticulitis with spasm was the cause of the condition for which operation was undertaken on a mistaken diagnosis. In three cases inflammation and purulent discharge had been observed about the mouths of the diverticula on proctoscopic examination. Postmortem studies confirmed the diagnosis in three instances. The histories seemed typical during life but no diverticula could be visualized by the roentgenograms, though spasm was apparent. At postmortem examination years later the diverticula were found in the sigmoid segment.

In reviewing the histories of patients with diverticulitis and spasm there seems to be a definite pattern by which this inflammation expresses itself. Over and over again, a middle-aged, or older, corpulent individual who has been habitually sedentary and constipated will have a sudden seizure of lower abdominal crampy pain. This will be accompanied by increasing constipation, often ushered in by passage of several loose stools. Distention will follow and nausea, often with vomiting as well. Feverishness and chilly sensations may be mentioned. Passage of fecal material becomes incomplete and unsatisfactory—sometimes with real tenesmus. Tenderness gradually centers toward the bladder and inguinal region just to the left of the midline. Upon examination, the temperature is usually elevated and the pulse rapid. The abdomen shows distention. There is tenderness in the lower quadrants of the abdomen, most frequently to the left of the midline, and there may be a tender mass palpable in the region of the sigmoid. The white blood count is significantly elevated in many cases. Examination of the stool may not be possible if the protective spasm is effective, as it usually is. After a period of three or four days the fever subsides, the tenderness becomes less, the

spasm relaxes and the patient feels better. The physician credits the result to his restriction of diet, antispasmodic drugs and rest in bed with or without heat or cold externally, and with or without the use of small warm rectal irrigations.

The study of our cases shows that in only rare instances does this condition occur under 40 years of age. There were only two patients in the 20's. Two others gave histories that indicated a possibility that this condition was present at 17 and 20 years, respectively. There were no patients in the 30's. In the 40's there were 14; in the 50's—31; in the 60's—36; in the 70's—21; and in the 80's—7. So that the peak age-incidence for diverticulitis with spasm is from 40 to 80 years. This is a great contrast to the age-incidence for appendicitis (Chart I).

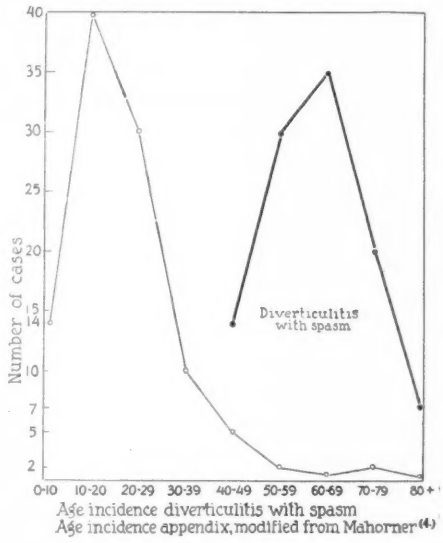


CHART I

The disease occurs about equally in males and females—61 to 50 in our series.

Pain was the most frequent symptom given in our series. It was lower abdominal, especially to the left side in 66 patients; in both lower quadrants in ten; in the right lower quadrant in five; epigastric in five; paraumbilical in three; in the left buttocks in two; in the left flank in one; and diffuse soreness in two. In the others no record is given. The pain was crampy usually, though in a few patients it was called constant. It settled in the left lower quadrant most often. Occasionally it radiated elsewhere—upper thigh in two, to testicle and penis in three; and to the costovertebral angle in three. The pain was relieved by rest, sedation, occasionally by enemas, and by bowel movements or by micturition.

Constipation (45 times) and diarrhea (37 times) were the next most frequent complaints, followed by distention (32 times), vomiting (28 times) and nausea (25 times). Slight fever was present in most patients and significantly high elevation in 29. Chills were infrequent (six times). Diminution in the caliber of the stools was noted by ten patients and tenesmus was a complaint in an equal number. Bright blood was observed 24 times and tarry stools eight times. Mucus and pus were also mentioned by a few. This occurrence of blood in the stools in 32 patients was confirmed by stool examinations. In ten of the patients there were complications, such as hemorrhoids five; rectal polypus one; rectal ulceration one; duodenal ulcer two; and gastric ulcer one, which might have accounted for the bleeding. If a correction is

made for these, bleeding was present in almost 20 per cent—a much higher figure than expected.

Other complaints of less frequency were loss of weight (22 times), bladder disturbances (12 times), weakness and fatigue (four times), loss of appetite (six times) (Chart II).

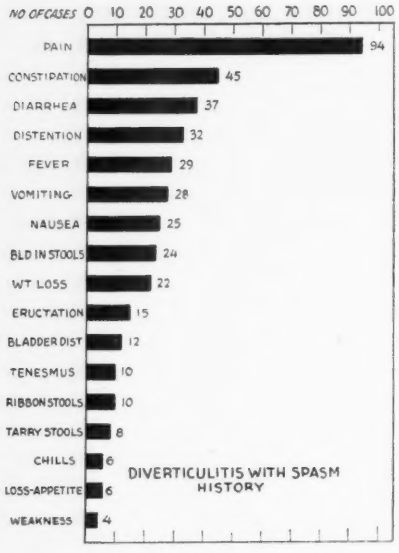


CHART II

On physical examination, many of the patients showed the degenerative conditions of age. This served to complicate the picture as some of the symptoms and signs were due to these conditions. Diverticulitis must be isolated from these diseases with their complaints and physical findings. Arteriosclerosis, arteriosclerotic heart disease, hypertension, coronary sclerosis, diabetes, obesity, arthritis, cholecystitis, benign prostatic hypertrophy, diaphragmatic hernia, *etc., etc.,* were frequently encountered in this group of patients.

The habitus of these patients was noted as obese (29 times), well-nourished (11 times), and thin (eight times). The other patients must have been nondescript or considered normal for their age-group.

Tenderness was diffuse in a large number but was noted in the LLQ (33 times); in both LQ's (13 times); in the RLQ (seven times); at McB's point (one time); in the LUQ (five times); in the CVA (three times); by pelvic examination (three times); and by rectal examination (five times).

TABLE I

DIVERTICULITIS WITH SPASM EXAMINATION

Tenderness	73
Mass	19
Spasm	15
Blood in stools	32
W.B.C. over 12000	29

Spasm was infrequent, being recorded 13 times in the LLQ and twice in both YQ's. A mass was palpable 12 times in the LLQ; once in the RLQ; four times by pelvic and twice by rectal examination. Distention and borborygmi were frequently recorded. The white blood count was over 12,000 in 29 instances and occasionally reached as high as 24,000. In some of the very elderly there was no sign of fever or of polymorphonuclear response even when there was a definite acutely tender mass (Table I).

Diverticulitis with spasm is a self-limited disease. The condition will

subside or improve in three to four days to one week under good medical care. The treatment is exactly the opposite to that of acute appendicitis. The surgeon must exercise restraint during this phase of the disease.

DIVERTICULITIS WITH COMPLICATIONS

When diverticulitis does not improve but goes over into some of the possible complications the problem is entirely different. We have encountered these complications of diverticulitis in 85 instances. In 39 of them there has been perforation, with peritonitis or local abscess. When these abscesses have been drained a fistula may result or a sinus into a dead space, or the abscess itself may burrow and open into another hollow viscus, giving fistulae of bizarre symptomatology. The wall of the infected bowel about the diverticula may harbor many small abscesses which repeatedly forming, call forth a fibrous reaction. This may lead to obstruction of the colon as may also the adhesions about a healing walled-off abscess. Finally, the diverticulitis may be complicated by carcinoma in the same area, or incidentally elsewhere, but masked by the inflammation. We have had 22 patients with diverticulitis and fistula but ten of them also had abscess, three had obstruction, one a combination of the two, and one had cancer. We have had 34 cases with obstruction but eight of them had abscess also and three had fistula and one had carcinoma. We have had 17 patients with carcinoma but two of them also had abscesses, one had obstruction, and three had fistulae.

DIVERTICULITIS WITH PERFORATION

We have recorded 39 cases of diverticulitis with perforation. In three of them there was a perforation into the free peritoneal cavity, with extensive peritonitis. Two of these patients recovered. In one, exploration with drainage was used; in the other, cecostomy was done. Both patients received sulpha drugs. In the other 36 cases a localized abscess of considerable size was found, and drained in most instances. Twenty-four of these patients recovered and 12 died in the hospital. Two of the deaths could not be helped, due to coronary occlusion 34 days after operation and hemiplegia from thrombosis of the left posterior cerebral artery 11 days after operation. This group of patients merges into the next two groups — diverticulitis with sinus and fistula and diverticulitis with infiltration and obstruction. Eighteen of the 36 fall into these duplicate listings.

In an analysis of the symptomatology and physical findings it is at once apparent that these patients are more ill from the start or do not improve under rest and therapy. The pain is severe or knife-like in almost every instance. The pain may radiate to the back, or toward the rectum, to the hip or thigh or into the penis. It is accompanied by nausea and vomiting and distention in a majority of cases. The temperature ranges at a higher

level, a greater number being from 101.5° to 104° F. The pulse rises with the fever, the white blood counts in 20 of these patients ranged from 12,000 to 25,000. Tenderness was uniformly present, in many cases described as exquisite. It varied in localization from the LLQ to the lower abdomen on both sides and occasionally to the RLQ and the costovertebral angles. It could more frequently be demonstrated by pelvic or rectal examination than in the spastic group. Abdominal muscle spasm was noted in 41 of these examinations. Referred and rebound tenderness was also frequently elicited. A tender mass could be felt either by abdominal, rectal or pelvic examination in the same proportion. Patients complained of bladder irritation or dysuria, of increasing constipation (13 times), of diarrhea (16 times), and diminishing size of the stools (five times), and of mucus and blood in the movements (ten times), loss of weight (nine times) and loss of strength and weakness occasionally were mentioned. Barium enemas showed extravasation of barium outside the bowel lumen on three occasions and free air in the peritoneal cavity on two examinations. There were three instances where the abscess perforated into the extraperitoneal rectal space and extended into soft tissues so that it simulated an extravasation of urine with swelling and gas crackling under the skin in the region of the scrotum and penis (Chart III, Table II).

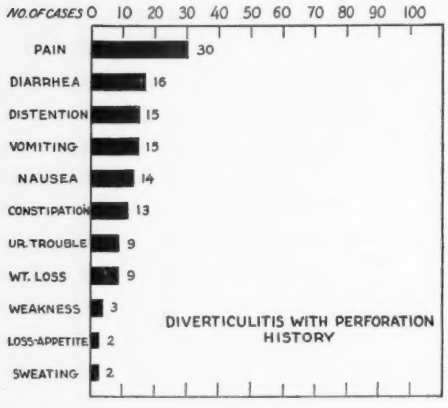


CHART III

TABLE II

DIVERTICULITIS WITH PERFORATION EXAMINATION

Tenderness	25
Fever	19
Spasm	16
Mass	16
Chills	3
Ribbon stools	5
Blood in stools	10
W.B.C. over 12000	20

DIVERTICULITIS WITH FISTULA

Diverticulitis with fistula started as an abscess which was opened or made its own way to the surface or into neighboring organs. In our 22 cases with known fistulae 11 have had the openings from the sigmoid to the skin, eight have had sigmoid to bladder fistulae, two have had sigmoid to urethra openings; two sigmoid to small intestine, one sigmoid to cecum; two sig-

moid to rectum; four sigmoid to vagina; one a sinus to the retroperitoneal tissues; one ischiorectal sinus; and one sinus into the mesocolon. In 11 cases there were more than one region involved — such as skin and bladder, *etc.* The skin had multiple fistulae in 11 instances (Table III).

TABLE III

DIVERTICULITIS WITH FISTULA

No. of cases	22
Skin	11
Single	5
Multiple	6
Bladder	8
Vagina	4
Rectum	2
Urethra	2
Small intestine	2
Large intestine	1
Ischiorectal	1
Retroperitoneal	1
One site fistula	11
Multiple fistulae	11

These patients may have burned out their infection in some instances so that their only complaints were the nuisance of dressing leaking fistulous openings. Those with fistula to the bladder were quite miserable with burning pain and frequency. Others had residual abscesses connected with the fistulous tracts. They had fever, loss of weight, loss of appetite and areas of tenderness. Every patient was a different problem depending on the stage of the infection, the age, and the general condition.

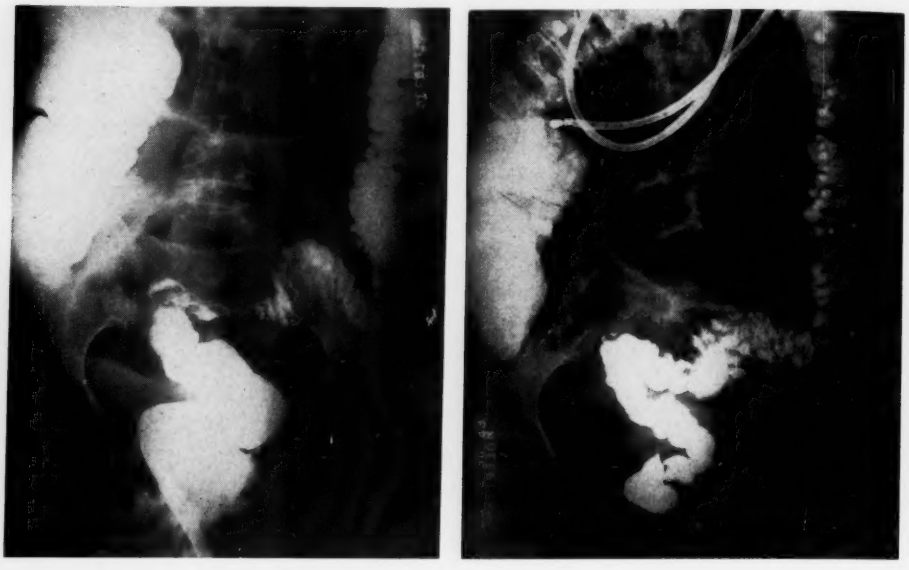
DIVERTICULITIS WITH INFILTRATION AND OBSTRUCTION

When the descending colon and sigmoid had suffered repeated infections in the diverticula, scarring and thickening took place, resulting in a gradual occlusion of the lumen. The bowel became infiltrated with connective tissue, hard, and lost its elasticity. Other possibilities for obstruction were adhesions about an abscess cavity and adherence of the small intestine to an acutely infected diverticulum. We have had 34 cases in which there was an obstruction to the intestine. Eighteen of these were partial obstruction at the sigmoid area; 13 were complete obstruction at the same region. There were three obstructions to the small intestines which were adherent to acute inflammatory masses (Fig. 1). In one of these there was a partial large bowel obstruction as well. The problems presented by this group were many in diagnosis and treatment as well.

DIVERTICULITIS ASSOCIATED WITH CANCER

In the group associated with cancer, the diverticulitis may have been present in a patient who has had cancer of the intestine as an incidental affair — being remote from the area. It always raised a question however. It may by chance happen that diverticulitis and cancer occur in the same place — *i.e.*, sigmoid or descending colon. Cancer of the female pelvic or-

gans may have been treated by radiation which also caused difficulty in diagnosis. In our cases there has been one cancer of the cecum, two cancers of the ascending colon, one cancer of the transverse colon, one cancer of the splenic flexure, three cancers of the sigmoid and one of the rectosigmoid junction. One patient had had cancer of the cervix treated by radiation. There were several cancers which perforated and stimulated diverticulitis with abscess. After drainage of these abscesses there was wide spread metastases within a very short period of time.



A B

FIG. 1.—A and B: No. 119330: Diverticulitis with spasm and small intestine obstruction due to adhesions to inflamed sigmoid.

DIAGNOSIS

Diverticulitis with spasm is fairly easy to diagnose. It may be confused with acute appendicitis. When there is such a doubt, and there may be if the sigmoid lies to the right side — a simple expedient would be to give a small barium enema very carefully. If it showed spasm in the sigmoid the diagnosis would be apparent. The trouble with this in most hospitals is that the emergencies come in at off-hours of the regular roentgenologists and there is a minimum of assistance for the resident staff to get this examination made.

In diverticulitis with infiltration there is partial or complete obstruction. Often the diagnosis from carcinoma is practically impossible. Even when the surgeon has the lesion in his hand he cannot be sure whether it is a chronic inflammation or a neoplasm. The pathologist has the same difficulty until he has cut the bowel open and made a section. An intact mucous membrane of the bowel would help to settle the issue for chronic inflammation

but a recent experience with an infiltrating carcinoma (like linitis plastica of the stomach) has made even this doubtful.

In diverticulitis with complications (this includes all the rest) there are diagnostic difficulties. The women give the gynecologists many worries. The left tube and ovary frequently become attached to the inflamed sigmoid. Many of these patients received a diagnosis of solid tumor of the ovary. The

FIG 2.—No. 160625: Diverticulitis showing picket-fence spasm above the area.

gynecologist gets a surprise when he performs a celiotomy and finds the huge sigmoid inflammation. This could be obviated by careful barium enema studies on tube and ovarian masses. Another pitfall for the gynecologist is after drainage of a pelvic abscess to have a fecal fistula form. He then decides that he must have opened the intestine at some point, which does not add to his contentment. Other conditions which may be considered in diagnosis are strangulated intestine, mesenteric thrombosis and carcinoma. Extravasation of urine has been considered in some cases. There is an associated infection in the genito-urinary tract frequently noted. Pyelitis, pyelonephritis or cystitis may clear up after diverticulitis has been eliminated.

The roentgenologist makes his diagnosis of diverticulitis from the presence of the diverticula; the associated picket-fence spasm above the area (often for a good distance) (Fig. 2); the absence of chronic distention in the large bowel above the lesion; and the relatively longer segment of bowel

involved in the picture. When he cannot pass the area from below he is often unable to make a diagnosis other than obstruction of the large bowel. Occasionally he can note the characteristic nodular appearance of cancer.

Other aides in fluoroscopic diagnosis are that diverticulitis is usually tender and the bowel wall may be distensible. The lesion may be fixed, not easily movable without pain. The spasm may relax so that the picture is quite different within a week of the earlier one. Carcinoma, on the other hand, is usually not sensitive, it is rigid and nondistensible, it is firm but not fixed, and the picture remains constant.

In perforation, free air may be demonstrated in the peritoneal cavity and extravasation of barium outside the lumen may be noted. This would occur with perforation of either diverticulitis or carcinoma.

TREATMENT

The treatment calls for good judgment and patience on the part of the physician and the patient. Diverticulitis with spasm should be treated conservatively. Expectant treatment following the lead given by the spasm of the bowel is the best. Put the patient in complete bed rest. Limit his diet to liquids; give him antispasmodic drugs — belladonna. Heat gives comfort to some, cold to others. Warm small enemas may clear the rectum and ease the inflammation. Sulpha drugs are not necessary. Small doses of phenobarbital before meals give comfort, according to Jones.

Perforation into the peritoneal cavity will result in exploration. Simple drainage may be employed, or not, depending on conditions. A fistulous opening will often result if drainage is used. Sulpha drugs should be pushed, Wangensteen suction, heavy sedation, and parenteral fluids. Transfusions should be given, as necessary, to restore blood volume and prevent anemia.

When localized abscess is present, incision and drainage is indicated. Extraperitoneal drainage should be done if possible. Care should be taken not to disturb the abscessed area any more than is essential.

For fistulae to the skin or bladder, defunctioning colostomy away from the area — in the right transverse colon, as advocated by Devine, is the best treatment in our opinion. In this clinic we divide the loop, cutting down its mesentery, and anchor each end well-separated at the extremities of a transverse incision. The inflammation in the sigmoid will either subside or go on to abscess formation. In the latter case incision and drainage may be necessary. The same procedure, defunctioning colostomy, is useful for obstructed diverticulitis where infection may be present and smoldering. Under this treatment the diseased bowel may open so that the colostomy may be repaired. But this will be after six months to one year. The defunctioned loop can be visualized by barium roentgenologic studies to ascertain its condition. If it scars-down to a narrowed lumen it will be necessary to resect it and do an end-to-end anastomosis while the Devine colostomy is still present. Then, after an adequate time for healing the colostomy openings can be brought together again. This may be done in one to two months.

This requires three operations but it is much safer when infection is still present. It avoids disastrous fistula and break-down of anastomoses done in infected areas. When infection is all burned-out, a direct attack with resection and end-to-end anastomosis is often successful in one stage.

Smithwick[7] made a splendid review of the surgical treatment in this condition in 1942. The literature since that time has contained no large series of cases. A chart of the treatment for the complicated cases, as carried out in this clinic, shows that there is very little standardization of operative procedures (Table IV).

TABLE IV

DIVERTICULITIS WITH COMPLICATIONS

No. of cases	85	W	65	D	20
No operation	9	W	8	D	1
Exploration only	1	W	1		
Exp. with Mick. only	1			D	1
1 + D	21	W	17	D	4
1 + D: Colostomy	14	W	7	D	7
In continuity	7	W	1	D	6
Obstructive	5	W	5		
With release s.i. obs.	2	W	1	D	1
Colostomy only	18	W	16	D	2
In continuity	10	W	8	D	2
Obstructive	7	W	7		
With release s.i. obs.	1	W	1		
Res.-Anastomosis	16	W	11	D	5
Immediate	9	W	5	D	4
Delayed	7	W	6	D	1
Side-tracking	1	W	1		

CASE REPORTS

CASE 1.—No. 3175: A 67-year-old professor, was first seen in the Strong Memorial Hospital on June 4, 1929. For 2.5 years he had had episodes of pain, fever, and tenderness in the left lower abdominal quadrant. Multiple diverticula had been demonstrated in the sigmoid and descending colon. For many years there had been chronic constipation accompanying and preceding these acute disturbances.

In the last year the attacks of pain had increased in frequency and severity. Tenesmus had been present during the last month. On the day before entry he had had severe pain in the LLQ. There was frequent desire to defecate with considerable colicky pain. By the next day he was quite uncomfortable. There was localized tenderness just to the left of the midline in the LLQ. There was spasm, rebound tenderness, and a tender palpable mass in the same area. The temperature had gone to 38.5° C.; pulse 120; and W.B.C. to 14,000. Conservative treatment was instituted consisting of smooth diet, small (1 pint) s.s. enema, hot compresses to the inflamed area and tincture of belladonna to relax the spasm. Under this treatment his fever declined in 48 hours, and a good evacuation was obtained by enemas. On January 18, 1931, he had a similar attack lasting three to four days. On October 10, 1932, he was admitted for another attack accompanied by bladder irritability. This lasted two days. Stools were negative for blood. His trouble cleared up without complication.

Over the next three years he had no attacks of diverticulitis but some cardiac infarction and slight rheumatic heart disease. By careful regulation of his life he avoided further attacks of diverticulitis. He died at the age of 77 from coronary sclerosis.

Postmortem study showed the descending and sigmoid colons to contain a great

many small diverticula. These had small orifices. The sacs measured 3 to 4 mm. in diameter. They were situated just adjacent to the root of the mesentery and contained fecal concretions. There was no evidence of inflammation present.

This case illustrates that there may be repeated attacks of infection in the diverticula with complete resolution of the inflammatory reaction.

CASE 2.—No. 197567: A 60-year-old woman was admitted to the Strong Memorial Hospital, October 25, 1942, with pain in the abdomen. For three days she had had generalized lower abdominal pain, without localization. On the day of admission it had settled in the RLQ. Bowels had become costive, with constant desire but small stools. There was nausea and vomiting on two occasions. No urinary symptoms. Upon examination, there was tenderness in the RLQ, slight spasm and rebound tenderness. There was no tenderness in the LLQ but there was slight rebound tenderness there also. The right CVA was tender. Pelvic examination was negative. Temperature 104° F., P. 120, R. 25, W.B.C. 8800, Urine—a trace of albumin.

At operation, the appendix did not appear abnormal. Exploration showed a hard sausage-shaped tumor in the sigmoid. It appeared to be inflamed—probably diverticulitis.

The removed appendix showed no inflammation.

Barium enema, taken on the fifth day postoperative, showed a narrowed spastic descending colon and sigmoid with small diverticula present in this area.

When a surgeon finds that there is nothing in the appendix to support his diagnosis, he should look for other causes, as in this case.

CASE 3.—No. 134598: A 56-year-old man was admitted to Strong Memorial Hospital on November 30, 1937. He had been perfectly well until the morning of admission, when he suddenly developed severe pain in the LLQ. He moved his bowels once but the pain became worse and he had passed no flatus since. There was a slight chill but no nausea or vomiting. Pain remained steady. Examination showed a moderately obese man with a pasty appearance. Temperature 39° C.; P. 118. The abdomen showed tenderness, spasm deep in the left lower quadrant, and distention. There were bilateral inguinal herniae, readily reducible. W.B.C. 20,700. A plain roentgenogram of the abdomen showed distended small bowel loop in the LLQ. The large bowel was not remarkable.

The diagnosis was thought to be secondary ileus from a pelvic abscess, perforation of a diverticulum, mesenteric thrombosis or strangulated loop of bowel. At exploration, the small bowel was dilated all the way to the ileocecal valve. The appendix was normal. Frank pus was found in the pelvis. Drains were placed and closure made. Culture showed *E. coli* and *B. aerogenes.* His temperature reached normal on the fifth day after operation. Convalescence was without incident. He had a barium enema study 21 days after operation. It showed a narrow spastic irritable sigmoid colon with multiple diverticula. He has remained in good health since discharge from the hospital.

The difficulties in diagnosis when a peritonitis is present are well shown by this patient.

CASE 4.—No. 176259: A 74-year-old woman was admitted to the Strong Memorial Hospital on March 31, 1941. Nine years ago she had constipation accompanied by gaseous distention. Her stools became smaller in caliber and she took laxatives to obtain bowel movement. Seven years ago a colostomy was performed in another hospital. One month ago she began to pass gas and fecal matter through her urethra. This was accompanied by burning pain and marked frequency. She lost 20 pounds in weight.

Examination showed a thin, tired, chronically ill person. There was marked distention of the abdomen. There were two fistulae on the left side of the abdomen. A rectovesical fistula could not be visualized but cystoscopic examination showed marked cystitis. Cystogram did not reveal the opening into the bowel, but barium enema showed an obstruction at the distal end of the sigmoid with marked irritation and diverticula. *E. coli* was cultured from the bladder and *S. albus* and *E. coli* from the two fistulous openings. She was put on sulphaguanidine. A transverse obstructive colostomy (Devine) was done on April 17, 1941. One month later she had no urinary complaints. Three months later she had gained weight. The fistulae no longer discharged fecal material. Four months later the urine was clear.

In July, 1942, she had an abscess about one of the fistulae, with some nausea and vomiting. Under compresses it drained without surgical interference. In April, 1943, she was doing nicely. The colostomy functioned well and she had no bladder complaints. She has not been seen since then.

When a patient has multiple fistulae, and especially one into the bladder, the easiest and surest way to get relief is by a simple defunctioning of the large bowel. This requires division across the lumen so that no contents can pass.

CASE 5.—No. 200303: A 44-year-old obese physician was admitted to the Strong Memorial Hospital, May 26, 1943, because of right hydronephrosis due to a stricture at the ureteropelvic junction. He had had ureteral dilatations without discomfort on two previous admissions. Shortly following the last dilatation, March 21, 1943, he developed a colon bacillus infection of the urinary tract. He was quite miserable and had a fever to 104° F. at times for two weeks following. The symptoms disappeared but he continued to have pyuria. On admission, retrograde pyelograms showed bilateral kidney infection and bladder infection with *E. coli*. The catheter to the right side was left in place to drain the right kidney pelvis. The next day his temperature became 103.6° F.; P. 140. Most of his complaints, however, were confined to the LLQ. He gradually developed lower abdominal spasm, more on the left than on the right, distention, a tender mass to the left of the midline, and a W.B.C. of 22,500. He showed a tender indurated mass by rectal examination. The infection subsided about one week under sulphadiazine and warm s.s. enemas. He was discharged on June 7, 1943. He was readmitted on August 31, 1943. For many years he had been constipated with occasional mild LLQ pain. A typical attack has been ushered in by two days of constipation, then the pain. Suddenly there would be passage of a good deal of gas followed by a bowel movement of "hard round pellets." This pain seemed to flare-up after ureteral dilatation. His most recent attack was one week ago. Barium enema showed evidence of marked obstruction at the rectosigmoid junction. The bowel was not dilated above the obstruction and there was nothing typical of a carcinomatous defect, though it could not be ruled out. By pressure, only a small amount of barium could be made to pass. He was advised to take sulphasuccinyl at home for a week and then return here for resection. He preferred to try a conservative course. He reëntered on October 8, 1943. He had not improved. Exploration showed a huge inflammatory mass occupying the whole pelvis. A transverse colostomy was done. Drainage of the abscess through the rectum reduced the fever after ten days. He discharged pus from the rectum until January, 1944. He had daily irrigation through the lower segment. He gained 40 pounds. Roentgenograms showed marked obstruction at the rectosigmoid. On July 8, 1944, he had a resection and an end-to-end anastomosis of the sigmoid colon. The gross specimen showed an extremely thickened bowel wall with dense fibrous tissue, a pin point-sized lumen, and intact mucous membrane. Hard fecoliths were present in the diverticula. Microscopic examination showed

acute and chronic inflammation. On September 16, 1944, the transverse colostomy was reunited in an end-to-end anastomosis. The patient has been well to date.

This is a complicated picture. The kidney infection and the acute infection in the diverticula were made worse by the almost complete intestinal obstruction. If the defunctioning colostomy could have been done sooner, the pelvic abscess might have been avoided. This delayed the operative procedures considerably.

CASE 6.—No. 158503: A man, age 51, was admitted to the Strong Memorial Hospital on October 16, 1939. Ten years ago he had had onset of vague LLQ pain and feeling of fullness in the rectum. This continued for 5–6 years unrelieved by any form of therapy. Five years ago he had had peritonitis from a ruptured sigmoid diverticulum. It was drained through a lower midline incision. This incision continued to drain fecal material and occasional pus since then. He has had episodes of fever with chills and sweating lasting three–four days. His diet has been soft and his bowels without trouble. One year ago a cecostomy was done and the sinus stopped draining and closed over. The cecostomy was then closed and, although he had no bowel trouble, he developed aching pains from the crest of the ilium to the midline on the left. He had pain when he lifted his left leg — the pain being referred to the left anterior thigh. He had gained weight and had not passed blood, pus or mucus in his stools.

On entry, he had a fever of 100.4° F., P. 110. He was a large obese man. The skin over his left back felt somewhat boggy. There were healed scars and a closed sinus at the lower end of the left abdominal incision. A hard sausage-like colon could be palpated, tender to pressure but slightly mobile. W.B.C. was 23,000. Barium enema showed irritability and a narrowed irregular area in the sigmoid. There was a suggestion of a soft-tissue shadow.

On conservative treatment with warm irrigations of the colon he became worse. The pain was more severe, especially along the iliac crest. There was a crampy mid-abdominal pain noted after micturition. He also had a severe crampy seizure in the left leg when there was peristalsis in the descending colon. W.B.C. remained at 23,000 level.

At operation, an incision was made along the crest of the ilium and carried down extraperitoneally. The bowel was exposed. It was hard and infiltrated. It was then exposed through the left rectus from the peritoneal side. No abscess was found but what amounted to a cellulitis of the sigmoid was present. He was put on short-wave diathermy, and ten days later an abscess drained spontaneously from the retroperitoneal incision. This incision was accordingly opened widely. His discomfort and pains disappeared. Culture showed *E. coli, Cl. welchii,* and *nonhemolytic Streptococci.* He was discharged, relieved, to his local physician after one month in the hospital. There has been no report since 1940, at which time he was healed.

This was an unusual picture, difficult to interpret. It had the appearance of psoas abscess. A cecostomy gave only a temporary type of relief as the bowel contents were never entirely diverted by this procedure. A defunctioning colostomy might have saved the extravasation into the retroperitoneal area.

CASE 7.—No. 233109: A 67-year-old woman was admitted to the Strong Memorial Hospital on June 1, 1945. She had been having dragging sensations in the lower abdomen for the last six months. She had noted some urinary frequency with burning. Her bowels had been regular, without pain or bleeding.

Two months ago a mass was noted protruding from the rima pudendi. She was an obese woman in no distress. Her examination was not remarkable except that

she had a complete procedentia with a myomatous nodule in the isthmus, moderate cystocele and rectocele. A La Forte repair with perineorrhaphy was done. Eleven days after operation she began to drain fecal material from the left angle of the incision. A diagnosis of rectovaginal fistula was made. There was a mass in the left lower quadrant with tenderness suggesting inflammation. She had a fever to 101° F.; and W.B.C. of 14,600. Ten days of treatment with sulpha drugs were given. Exploratory celiotomy showed a large mass of inflammatory tissue with the sigmoid on top of it and the bladder and left broad ligaments attached to it. There was a perforation in the sigmoid and an abscess with a thick wall. The area was drained. *E. coli* and *nonhemolytic Streptococci* were cultured from the abscess cavity. Convalescence was stormy. Transfusion and parenteral feedings and sulphaphthalidine were given. She was discharged after two months, improved.

On October 11, 1945, barium enema showed many diverticula of the proximal sigmoid, with fecal fistulae still present. She continued to drain blood, pus and fecal matter from two sinuses on the abdominal wall. She will have a defunctioning colostomy done.

This is the kind of result that gives the gynecologist grey hairs. He thinks that he has made a technical error somewhere in his work. These complicated diverticulitis cases are among the most difficult problems in surgery.

CASE 8.—No. 8178: A 65-year-old woman was admitted to the Strong Memorial Hospital on July 19, 1933. Three weeks before admission she had fever, low abdominal and rectal pains which were very severe. She had a tender mass in the pelvis on the left side. For four days she had complete obstipation, nausea, and fever. She vomited for three days and then passed gas per rectum. When enemas were given fever and pain occurred. She had symptoms of bladder irritation also. She was known to have multiple diverticula of the colon from previous studies.

On examination, she was well-nourished but showed recent weight loss. She was pale. There was slight discomfort on deep palpation in the left iliac fossa. Pelvic examination showed the uterus fixed to a hard indurated mass the size of an orange in the left side of the pelvis. Her vital signs were within normal range. R.B.C. 3,550,000, Hb. 75 per cent; W.B.C. 10,000, Blood chemistry normal. Proctoscopic examination revealed a firm fixed mass at the rectosigmoid junction and almost complete obstruction at this point. No cancerous tissue was visible. Exploration showed a 2-cm.-sized nodule in the left liver lobe. This was confirmed by the other members of the team. It seemed to be metastatic cancer. There was a mass of firm nodular tissue at the rectosigmoid junction. A loop-colostomy was made in the descending colon. No specimen was secured but a bad prognosis was given to the family. She convalesced without incident, and was discharged on October 9, 1933. Ten days later she was readmitted with pain in the lumbar region. Roentgenograms showed arthritis but no evidence of metastasis.

In January, 1934, she had good control of her colostomy. She had gained weight and strength. Irrigation of the rectal segment showed that there was a good communication with the abdominal opening. She still had a stricture there and it could not be passed from the rectal or abdominal side.

In October, 1945, she was alive, and had no complaints referable to the large bowel. At this time she was troubled with arthritis, arteriosclerosis and an early cataract. Apparently the nodule in the left lobe of her liver is an adenoma, a hemangioma, or some such benign lesion.

This patient illustrates the difficulties in prognosis when no microscopic proof is available. The family was given a poor outlook but time has proved that this was not warranted.

CASE 9.—No. 234407: A 73-year-old woman was admitted to the Strong Memorial Hospital on July 8, 1945. Eleven months ago she first noted diminution in the size of her stools, with rectal bleeding. She began to have episodes of crampy abdominal pain usually followed and relieved by small diarrheal stools. Three months ago she had barium studies which showed diverticulitis, with partial obstruction. She was treated by her physician with smooth diet and atropine. She regained some of the weight she had lost. A second roentgenologic series was likewise interpreted as diverticulitis. Upon examination she was poorly-nourished, her abdomen showed moderate distention, with borborygmi. There was no tenderness but a movable mass was easily palpable in the sigmoid region. She had no anemia. W.B.C. 5,000. Barium enema was done here. Diagnosis of carcinoma at the rectosigmoid junction was made. Proctoscopic examination showed a tender rectum and no carcinoma was visible. She was put on sulphadiazine. She was explored and a resection of the rectosigmoid area was done. An end-to-end anastomosis was made in the pelvis. The specimen showed carcinoma and diverticulitis, with inspissated barium in the small sacs. Recovery was without incident. She was discharged, healed, 16 days after operation. Follow-up, November 14, 1945, showed that she had gained 23 pounds and had had no trouble of any kind since operation.

It is not surprising that carcinoma and diverticulitis may occur in the sigmoid segment at the same time. It is frequently impossible to decide which the lesion is without the test of time.

CASE 10.—No. 227568: A 64-year-old man was admitted to the Strong Memorial Hospital on January 1, 1945. He was well till two years ago. At that time he passed black blood from the rectum on three occasions, with no other symptoms. This left him weak. Roentgenograms showed a duodenal ulcer for which he received medical treatment, with favorable response. One month ago he had slight tenderness in the LUQ. It sometimes would extend across the upper abdomen and was relieved by belching of gas. Bowel habits had remained regular but the stools were watery in consistency. For four days his temperature spiked to 100.8°–102° F. Pulse remained at 80. The abdomen was protuberant and distended. There was moderate tenderness and spasm in the LUQ. R.B.C. 3.9, Hb. 11.8 grams; W.B.C. 13,950; stool guaiac-negative. Temperature fell to normal and pain disappeared. Barium enema study was then made. Barium showed numerous diverticula of the sigmoid. Patient could not retain the barium and no filling occurred beyond the descending colon. The night following this examination he had a chill, temperature to 103° F., and he passed some frank pus and blood per rectum. Blood culture was negative. The stools showed blood on six examinations during this hospital stay. He quieted down and was discharged for medical care, with diagnosis of diverticulitis of the sigmoid with rupture of an abscess into the rectum.

Three weeks later he was readmitted to the hospital. His pain had never abated and he had had a few episodes of nausea and vomiting. The stools did not contain blood or pus. Last night he had a chill and he became distended. There was unbearable pain in both lower quadrants. His vital signs were not remarkable. He had exquisite abdominal pain and tenderness. There was marked distention and no peristalsis was elicited. W.B.C. 6,400. A diagnosis of generalized peritonitis was made. He was started on sulphadiazine and Wangensteen suction. He was transfused and given parenteral fluids. His large bowel distention became worse and it was feared that the cecum might perforate. Under local anesthesia a McBurney incision was made. Dense green fibrinopurulent exudate covered everything. It was stripped off until the cecum could be identified and a rubber tube inserted. He made good recovery and was discharged improved with the diagnosis of ruptured diverticulitis of the sigmoid and generalized peritonitis.

Three months after discharge he passed black and red blood from the rectum. He lost from a teaspoonful to a cupful per day. He became very weak, lost ten pounds. His cecostomy continued to drain. Barium enema showed filling defects in the region of the sigmoid and an obstructive lesion near the splenic flexure. Roentgenologic examination *via* the cecostomy showed marked dilatation of the transverse colon and a carcinoma close to the splenic flexure. At operation, this was a mass of adenocarcinoma which involved the mesocolon close to the stomach and invaded posteriorly into the region of the superior mesenteric vessels. It was impossible to mobilize it. Accordingly, the transverse colon was transected and the distal end turned in under continuous silk sutures. The proximal end was anastomosed to the side of the descending colon. He was much more comfortable following this procedure. He gradually became more anemic and weaker. He died at home, 11 months after his first admission.

Perforation of the diverticula into the bowel at one time and into the peritoneal cavity at another completely masked the real lesion at the splenic flexure. It was probably an advanced lesion as it was inoperable when the diagnosis was finally reached.

CASE 11.—No. 193554: A 49-year-old woman was admitted to the Strong Memorial Hospital on July 15, 1942. She had had a ruptured gangrenous appendix with peritonitis 3.5 years ago. A left broad ligament abscess developed and was drained. Numerous abscesses at times had formed in both right and left lower quadrants ever since. A perirectal abscess was treated by incision and drainage one year ago. She had had five operations altogether. Roentgenograms two years ago showed diverticula of the large intestine. She entered here because of discharge from two areas in the right lower quadrant, accompanied by pain.

In her youth she spent three months in a tuberculosis sanitarium and was discharged with "arrested tuberculosis." She had chronic right frontal sinusitis. She had frequency, urgency and dysuria at the end of micturition when the abdominal attack flared up. Slight exertional dyspnea and ankle edema were present. Rheumatic fever was considered as a diagnosis five years ago.

Examination: T. 37.2° C.; P. 80; R. 20. The abdomen was obese with numerous scars, McBurney, left lower quadrant, left rectus low, right flank. There were two sinus openings with minimal serous discharge in the right lower quadrant. The whole abdomen was tender, mostly so in the right lower quadrant.

Laboratory Data: W.B.C. 10,000. Hb. 14.7 Gm. The urine showed occasional white blood cells. Wassermann negative. Gastric analysis—free hydrochloric acid present. Barium enema—diverticulitis with spasm in the descending colon. Michel clip near ileum. Excision of scars in the right lower quadrant with the clip was done. There was pus in the sinuses; which did not appear to enter the bowel. Culture showed no growth. Microscopic examination showed acute and chronic inflammation and foreign body reaction about the clip. No tuberculosis or other pathologic picture noted. The wound healed well and she was discharged August 5, 1942.

She entered the Strong Memorial Hospital a second time, September 30, 1942, because of bleeding from the sinus in the left lower quadrant. She had a feeling of fullness in the left lower quadrant, the diameter of her stools had greatly decreased. This sinus was traced into the sigmoid, excised, and the base turned in under a purse-string. It appeared to be a diverticulitis. Culture showed no growth.

Her third entry was on January 5, 1943. Barium studies revealed a persistent narrowed area in the sigmoid, probably secondary to a peridiverticulitis. She was treated conservatively with mineral oil and atropine which gave symptomatic relief.

The fourth admission was on February 9, 1943, because she had a "bubbling sensation in the bladder" one week before and had passed gas, mineral oil and liquid

feces in her urine ever since. She presented a palpable mass in the left lower quadrant with tenderness and increased heat over the area. Her urine was clear but packed with white blood cells. Urine culture grew *B. pyocyaneus*. White blood cells 14,000. Hb. 15.2 Gm. Pelvic examination revealed a movable tender mass in the left lower quadrant above the cul-de-sac. A Devine colostomy was done and the patient put on sulfathiazole and sulfasuccidine. A diagnosis of diverticulitis of the sigmoid with intestinovesical fistula was made. She was discharged on March 13, 1943.

She came in for the fifth time on July 6, 1943. She has had "heavy pressure in the rectum" and smarting and burning on urination. After suitable preparation, July 16, 1943, a resection of the scarred area of the sigmoid with an end-to-end anastomosis was made. There were many thick adhesions about the area and it was necessary to resect 20 cm. of ileum which was damaged in freeing it. This was anastomosed with end-to-end anastomosis about 16 cm. from the ileocecal valve. Convalescence was stormy for a few days but then uneventful. *B. pyocyaneus* and *E. coli* were cultured from the urine. Pathologic section showed acute and chronic diverticulitis of the descending colon and sigmoid.

A sinus developed in the right lower quadrant and was followed into the retroperitoneal tissues of the right flank and drained on August 28, 1943. This sinus showed chronic granulation and hyperplastic squamous epithelium. She was discharged on September 19, 1943.

Her sixth admission showed the colostomy functioning well. She had a well healed anastomosis, as seen by barium enema. On this admission a sinus went through the abdominal wall into the peritoneal cavity. It was drained. There was no evidence of a pelvic abscess.

She came a seventh time because of pain in the right flank, in the right lower back and in the right hip, with radiation to the medial aspect of the right thigh. The sinus in the right lower quadrant had been draining blood. On February 9, 1944 the four sinuses were dissected out widely from the opening. One went to the iliac bone, which was intact, one to the retroperitoneum back of the cecum, one to the right upper thigh and a fourth into the pelvis. A typical blob of actinomycotic pus was identified and saved for culture and microscopic section. The tracts were packed open with vaselined gauze drains. Thread forms were seen in the gram stain but no actinomyces were isolated. The microscopic section showed actinomycosis. Actinomyces were isolated by the bacteriologic laboratory on March 3, 1944. On April 28, 1944, the peritoneum was opened and the tract traced to a cavity in back of the uterus. A No. 18 catheter was sewed in and penicillin instilled into this sinus daily and given by continuous intravenous drip as well. Over a two-weeks period 2,500,000 units of penicillin were used. She was discharged improved on May 20, 1944.

She was admitted on February 5, 1945, and had the colostomy restored by an end-to-end anastomosis. She had gained 30 pounds in weight and was an entirely different woman. The bowel functioned nicely after operation. She was discharged, March 9, 1945, without complaints of any kind.

She was seen on November 3, 1945. She was "the picture of health." There were no complaints.

This patient represented many possible causes for her fistulae. The old tuberculous history, the foreign body, and the diverticulitis with bladder fistula were possibilities which were weighed carefully. Repeated tests for fungi had been made but it was not till late that a diagnosis of actinomycosis could be supported. This apparently accounted for her tube-ovarian abscess as actinomycosis has been reported from this area in about 75 cases.

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DISCUSSION.—DR. CARL EGGERS, New York City: Doctor Morton has given us a very good idea of the entire subject, including the question of diagnosis, course of the disease, and treatment. I should like to add a few points to this. In 1939, I read a paper before the New York Surgical Society dealing with 82 cases of this condition; since then I have had 24 additional cases, a total of 106. Sixty-one were in the group of uncomplicated cases, subsiding without operation. Forty-five patients developed complications. Of these, 43 were operated upon, and two refused operation.

The operations varied a good deal depending on the indications. Some patients had an exploration done, others had drainage or colostomy or cecostomy, with or without drainage. Twelve patients had a resection performed. There were 25 perforations; 23 perforated externally, producing abscess or peritonitis, while two perforated into the urinary bladder. There were nine postoperative deaths, confined entirely to the acute perforations. This makes 36 per cent of the 25 perforations, or about nine per cent of the total. The 12 in whom resection was done recovered. There were a few late deaths from complications or associated carcinoma.

Naturally, our interest in this condition must center largely on the possibility of preventing death in the cases with acute perforation. All the other manifestations of the disease require the same careful attention as do all colon lesions. Unfortunately, we know of no definite way to prevent perforation. These patients are usually admitted as acute emergencies. Perhaps instructing general practitioners to send cases in earlier might help. Patients known to have diverticulosis should be instructed to seek advice as soon as acute symptoms develop. To some degree perforation may be guarded against by attention to the bowels and by the administration of mineral oil. In patients who have recovered from an attack of diverticulitis and who continue to have occasional pain, operation may be considered prior to a possible perforation.

Two interesting cases of this group were those with perforation into the urinary bladder. Both were known to have diverticulosis and had had diverticulitis. The chief symptom was the passage of gas through the urethra. In the first patient I separated the two viscera and closed the perforations. He made a good recovery but had a recurrence about two years later. The perforations were again closed and soft tissue interposed with good success. In the second case, a man who had perforated locally several times before and been drained, we did a resection of the sigmoid and closed the bladder opening.

DR. HARVEY STONE, Baltimore, Md.: There are two comments I would like to make on Doctor Morton's paper and on this general topic. The first concerns blood in the stool. You will recall from Doctor Morton's figures that this is one of the more frequently occurring symptoms of the disease and, as I remember, in these cases in which other sources of bleeding such as hemorrhoids might be excluded, there were some 24 patients who had blood in the stool attributable apparently to the diverticulitis

itself. So it is by no means a rare symptom of this condition. I should like to present this relationship from a somewhat different standpoint.

About three years ago I presented a paper before this Association concerning the occurrence of large hemorrhage into the bowel, of obscure origin, and of that group of 71, on protracted study, the only cause to which the bleeding might be attributed in eight cases was diverticulosis. So I think it should be borne in mind that the outstanding symptom may be sudden profuse bleeding into the bowel. Another point has just been referred to by Doctor Eggers, the relationship to bladder fistulae. Again, I want to emphasize a slightly different aspect of that. It is our custom to treat conservatively cases which we believe to have acute diverticulitis, reserving operation for complications that more or less compel it. But in two instances, during the conservative handling of these cases, the patient developed urinary symptoms, frequency, urgency, and pain on voiding. In both cases the patients were promptly operated upon, and there were found adhesions between the sigmoid and bladder but no actual perforation. I should like to draw attention to the advisability of anticipating the formation of fistulae when these urinary symptoms present themselves, and urge that as a reason for prompt operation to forestall development of a fistula.

Dr. Vernon David, Chicago, Ill.: I would like to take a somewhat different view about the causal relationship of diverticulitis of the colon to hemorrhage from the large bowel, as discussed in Doctor Morton's instructive paper. It would seem to me a rather questionable doctrine to go out from this Association, to regard diverticulitis of the colon as a relatively common source of hemorrhage when there is so little reliable evidence to prove it. The basis for belief is founded on dogmatic statement or because other recognizable sources of hemorrhage have not been found. It is always possible that small adenomas or nevi may be the source of relatively minor hemorrhage and it has been well-pointed out that large or massive hemorrhage may come from sources undiscoverable even at autopsy. Until definite pathologic evidence is forthcoming, I feel that we should be reluctant to place too much emphasis on diverticulitis as a source of hemorrhage, as it engenders a sense of complacency which might well lead to overlooking a small carcinoma or a bleeding polypus.

May I add another serious, but rather rare, complication of diverticulitis to Doctor Morton's impressive list, namely, pyelophlebitis, with multiple liver abscesses, of which I have seen two instances.

Dr. Fraser B. Gurd, Montreal, Quebec: I would like to express my appreciation of this paper, and I want to bring up one point only. It would seem that in recent years the number of cases of diverticulitis, with complications, has increased, both the obstructive type and the perforating peritonitis type. We have come to the conclusion with a fairly large number of cases, that the performance of right-side, transverse, defunctioning colostomy is the most useful procedure, whether associated with drainage in the left lower quadrant or not. It seems that one of the chief objections to the use of Devine's procedure is the likelihood of hernia complicating the after-course of such cases.

We have, in recent years, used the technic of upper right transverse incision, that is to say, an incision through the skin reaching from approximately two centimeters to the left of the midline and extending outward to slightly beyond the lateral border of the right rectus. The anterior aponeurosis covering the rectus is split in the direction of its fibers and the rectus muscle, together with the ninth intercostal nerve, is displaced toward the midline. The posterior aponeurosis and peritoneum are then similarly incised. In this way a sufficiently large opening can be obtained to permit the hand to be introduced and careful manual examination of the abdominal viscera carried out, with special reference to the sigmoid. A portion of the great omentum corresponding to that part of the right transverse colon which will be used for the

double-barreling of the bowel is then removed. After the loop of transverse colon has been pulled out of the wound, a suture of the parallel portions over a distance of at least 12 cm. has been carried out, one clamp is introduced medial to the rectus muscle and attached to the bowel. The other clamp is introduced lateral to the rectus muscle and the bowel is divided between them. The two colostomy openings are thus placed on each side of the undamaged rectus muscle. The posterior aponeurosis and peritoneum is partially closed behind the muscle and the anterior aponeurosis and skin are sutured between the two openings, which are, thus, seen to be about six or seven centimeters apart.

It is an easy matter to keep the colon clean. With lesser space between the rosettes it becomes increasingly difficult to defunction the left bowel. The fact that the left rectus is between the bowel ends makes certain that no considerable herniation can occur.

DR. JOHN MORTON, JR., Rochester, N. Y. (closing): I wish to thank all the members who so kindly discussed the paper. I used to teach students that you could tell the difference between diverticulitis and carcinoma by the fact that with diverticulitis there was no bleeding. This statement was in all the textbooks; but I notice that the textbooks now say that bleeding occurs in 20 per cent of cases. Up to the last edition of Homans' it was given as a diagnostic point that in diverticulitis you would not expect bleeding. In our cases we tried to rule out all other factors. In one case we had massive hemorrhage, as described by Dr. Harvey Stone, with the blood count down to less than 1,000,000 cells.

One of the very interesting types of perforation is that in which the perforation is extraperitoneal near the bladder. This gives the urologists difficulty in diagnosis. They think they have extravasation, with gas-crackles in the tissues about the bladder. Diverticulitis in association with infection in the kidney and ureter has been commented on in the literature, and we have had several instances. Probably one reason that this disease has interested me so much is that there have been complications in many cases. I operated upon one woman eight or nine times because she had a fistula that would not close. We resected it early, did a defunctioning colostomy later and, finally, after the seventh or eighth operation, we found that she had actinomycosis. She cleared up completely under penicillin, and is now an entirely different person.

The cases I reported with hemorrhage were those with spasm only; of those with complications many had hemorrhage into the bowel; all with carcinoma did, of course. At operation the surgeon has difficulty in telling what he has, even with the lesion in his hand. I have handed it to the pathologist and have had him confused. I used to think if you split the bowel open and saw an intact mucous membrane, you could say it was diverticulitis, but I have been fooled on that and have found carcinoma. Altogether it is quite a problem.

RESECTION OF ABDOMINAL CARCINOMAS INVOLVING THE LIVER AND SPLEEN SECONDARILY*

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THE PURPOSE of this communication is to summarize the experiences gained in a limited series of patients who, at celiotomy presented carcinoma primary in an abdominal viscus with direct spread on to the liver or with metastases in the liver or spleen, and in whom the primary growths were excised *en masse* with the spread into the liver: when hepatic or splenic metastases were present the primary growths were excised as well as the metastases, at the same sitting.

The patients are divided into two groups: those only with direct spread on to the liver and those with discrete metastases in the liver or spleen. The histories are summarized as follows:

DIRECT SPREAD ON TO THE LIVER

CASE REPORTS

Case 1.—Nels. And. (261816): Male, age 68. Large palpable mass in the left upper quadrant. Roentgenograms revealed filling defect in lower stomach.

Celiotomy revealed a large carcinoma primary in lower stomach with direct spread on to the under surface of most of the left lobe of the liver. The lower three-fifths of the stomach bearing the neoplasm was resected *en masse* with the left lobe of the liver. Interrupted mattress sutures were inserted along the freshly cut-surface of liver to arrest hemorrhage. Pólya type posterior gastrojejunostomy (Fig. 1).

The patient is well and at work in a factory five years later.

Case 2.—Zarog. (263077): Female, age 58. Large carcinoma of hepatic flexure with extension on to undersurface and anterior edge of right lobe of liver; also, loop of ileum adherent to, and invaded by, carcinoma.

At operation, right hemicolectomy was performed including lower 30 cm. of ileum and corresponding mesenteries. The portion of liver on to which the carcinoma had extended and which measured 10 x 6 x 4 cm. was also resected *en masse* with the above. Interrupted mattress sutures were inserted along the freshly cut-surface of the liver (Fig. 2).

The patient, a diabetic, is living, well and normally active four years and ten months later.

Case 3.—Wei. (367851): Female, age 51.

Operation revealed a carcinoma of the pyloric portion of the stomach with direct spread on to the upper anterior aspects of the head of the pancreas and spread on to the liver in the region of the previous gallbladder bed. (Cholecystectomy had been previously performed.) Resection of the lower three-fifths of the stomach, areolar tissue of the porta hepatis, anterior superior portion of the head of the pancreas, first segment of duodenum (up to the junction with second portion) and nodes about the celiac axis with peritoneum over the anterior surface of the body of the pancreas and portion of liver to include old gallbladder bed, was carried out *en masse* (Fig. 3).

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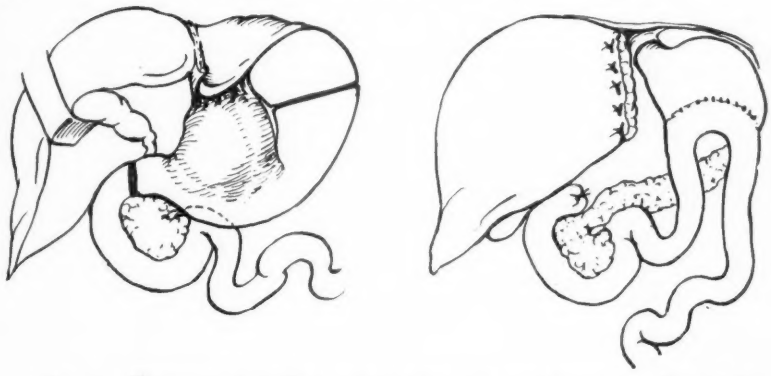

FIG. 1.—Diagram of radical gastrectomy for carcinoma invading under surface of left lobe of liver (Case 1). The latter was resected *en masse*, with major portion of the tumor. Patient alive and well, without evidence of recurrences five years later.

Convalescence was uneventful and the patient is living and well, 5 months after operation, without clinical evidence of recurrence.

Case 4.—Comin. (369037): Male, age 40.

Two and one-half years previously received radical gastrectomy for carcinoma of stomach in another institution. At this admission complained of upper abdominal pain and vomiting after eating small quantities of food.

Celiotomy performed and extensive recurrences found about site of gastrojejunal anastomosis and in transverse mesocolon. There were extension on to under surface of left lobe liver and on to body of pancreas. Resection of all the remaining gastric stump with body and tail of pancreas, spleen, extensions on to left lobe of liver, transverse mesocolon and transverse colon and loop of jejunum employed for gastrojejunostomy. The continuity of the upper jejunum was reëstablished by end-to-end anastomosis. The terminal duodenum was anastomosed to the jejunum below its repair and the next long loop of the latter was brought up for esophageal anastomosis; entero-enterostomy was performed between new afferent and efferent jejunal loops.

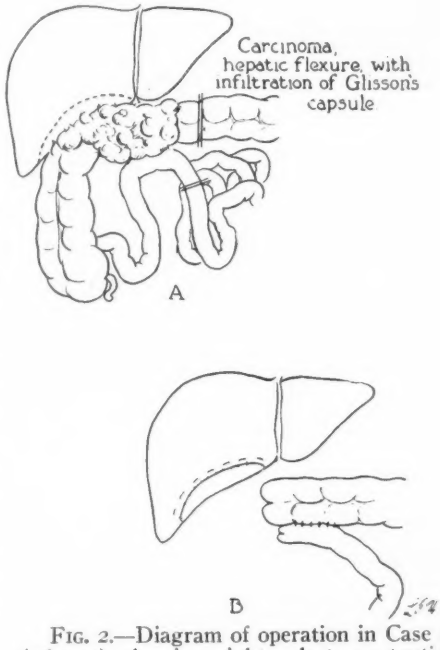

FIG. 2.—Diagram of operation in Case 2 (263077) showing right colectomy *partial hepatectomy* and partial enterectomy for large carcinoma of hepatic flexure that had spread onto right lobe of liver and secondarily invaded a loop of ileum. Patient alive and well, without evidence of recurrences four years and ten months later.

Five months after operation the patient is consuming a liberal diet and although still asthenic presents no clinical evidence of rapidly advancing carcinoma.

DISCRETE METASTASES IN LIVER OR SPLEEN

Case 5.—La. (365356): Male, age 36.

Two years previously received exteriorization resection of carcinoma of upper

descending colon, in another institution. At this admission presented recurrences in abdominal wall about the previous left paramedian incision. The largest recurrent nodule was suppurating.

The segment of left abdominal wall presenting recurrences was isolated by elliptical incisions extending from skin through peritoneum. It was then observed that the remaining descending colon was involved by the recurrence. There was extension of carcinoma into the upper left retroperitoneal space and there were four discrete metastases in the spleen. The entire region of recurrences was excised *en masse*, including spleen,

FIG. 3.—Case 3: Photograph of surgical specimens consisting of (P) pyloric portion of stomach with (C) carcinoma in its lower portion (D) first segment of duodenum; (P) anterior portion of head of pancreas; (E) areolar tissue from porta hepatis; (L) segment of liver from about old site of gallbladder with (T) direct spread of carcinoma. Patient living and clinically well five months after operation.

retroperitoneal tissues, left half of transverse colon, entire descending colon and segment of abdominal wall. Double-barrel colostomy, midtransverse colon to upper sigmoid. This was later closed (Fig. 4).

The patient is clinically well and back at work full-time, seven months after operation; he is a physician.

Case 6.—Sol. (347132): Male, age 56.

Epigastric pain, three months duration; spherical mass palpated in epigastrium. At operation, the body and tail of the pancreas and spleen were resected for carcinoma arising in the midportion of the body, and measuring 10 x 7 x 3 cm. A metastatic mass, meas-

uring 3 cm. in diameter, situated in the right lobe of the liver near the anterior margin was resected with wedge-shaped segment of liver 6 x 6 x 5 cm. Uneventful recovery from operation. Died five months later of carcinomatosis.

Case 7.—Seeg. (349169) : Female, age 56.

Clinical history typical of acute cholelithiasis. At operation, multiple large metastases were found in liver about gallbladder. These apparently afforded clinical sign of rigidity in right upper quadrant and were the cause of pain. These large metastases were excised from the liver about the gallbladder and the latter, which was thickened and contained calculi, was also removed. The aggregate weight of the metastases was 594 Gm. The patient was relieved from pain but survived for only three months, dying of carcinomatosis. Histologic examination of the resected metastases revealed them to be composed of closely packed small anaplastic cells with minimal stroma. Necropsy was not obtained.

Case 8.—Dal. (142882) : Male, age 69.

Large upper abdominal mass. Roentgenograms revealed pyloric obstruction.

At operation, the liver extruded itself through the incision, with spontaneous fissuring of several of the metastases, resulting in severe hemorrhage. It was the liver enlarged by multiple metastatic masses that produced the upper abdominal mass. Excision of several of the metastases, each measuring 4 to 8 cm. in diameter, was carried out as a means of arresting the hemorrhage. To relieve the obstruction a pylorectomy, bearing the primary growth, was performed with Pólya gastrojejunostomy.

The patient succumbed 24 hours later, presumably of shock.

Case 9.—Gra. (361481) : Female, age 60.

Carcinoma palpable about 10 cm. above anal sphincter.

At operation, the lesion in the lower rectal colon was found to be about 4 cm. in length and to completely encircle the bowel. There was a tumor mass, 4 cm. in diameter, replacing the left ovary, a metastatic mass, 2 cm. in diameter, in the mesentery of the lower jejunum and a single metastatic mass, 2 cm. in diameter, in the right lobe of the liver. The latter was excised, and the mesenteric metastasis also resected. The left tube and ovary were resected. A redundant loop of sigmoid, 20 cm. in length, bearing the primary growth with corresponding mesentery was resected and low end-to-end anastomosis of the colon performed. A loop-colostomy was performed in the descending colon. The latter was closed six weeks after the previous operation. Satisfactory condition at home for four months; returned to hospital because of symptoms of low grade intestinal obstruction. Exploratory celiotomy again performed revealing generalized carcinomatosis; dense infiltration of entire pelvis by carcinoma. Loop-colostomy transverse colon. The patient died 5.5 months after the initial operation.

Case 10.—Pleu. (364479) : Male, age 62.

Diarrhea and blood in stools for seven months. No weight loss. At operation, a half fist-size carcinoma was found in the lower pelvic colon—half of it extended above the reflection of peritoneum from the pelvic floor. On the anterior surface of the right lobe of the liver a metastatic nodule, 1.5 cm. in diameter, was discovered. No other palpable metastases. The low midline incision was extended upward and the hepatic metastasis resected. A segment of pelvic colon, 18 cm. in length, bearing the primary growth together with corresponding mesentery was then resected and end-to-end anastomosis performed (Fig. 5). Since the lesion had produced appreciable obstruction and the upper segment of the anastomosed bowel was edematous a loop-colostomy was performed above the anastomosis. This was closed six weeks later. The patient is living, well and normally active as a machinist, seven months after operation.

Discussion.—In the series of ten patients in whom resections of the primary growth and extensions or metastases to liver or spleen were excised

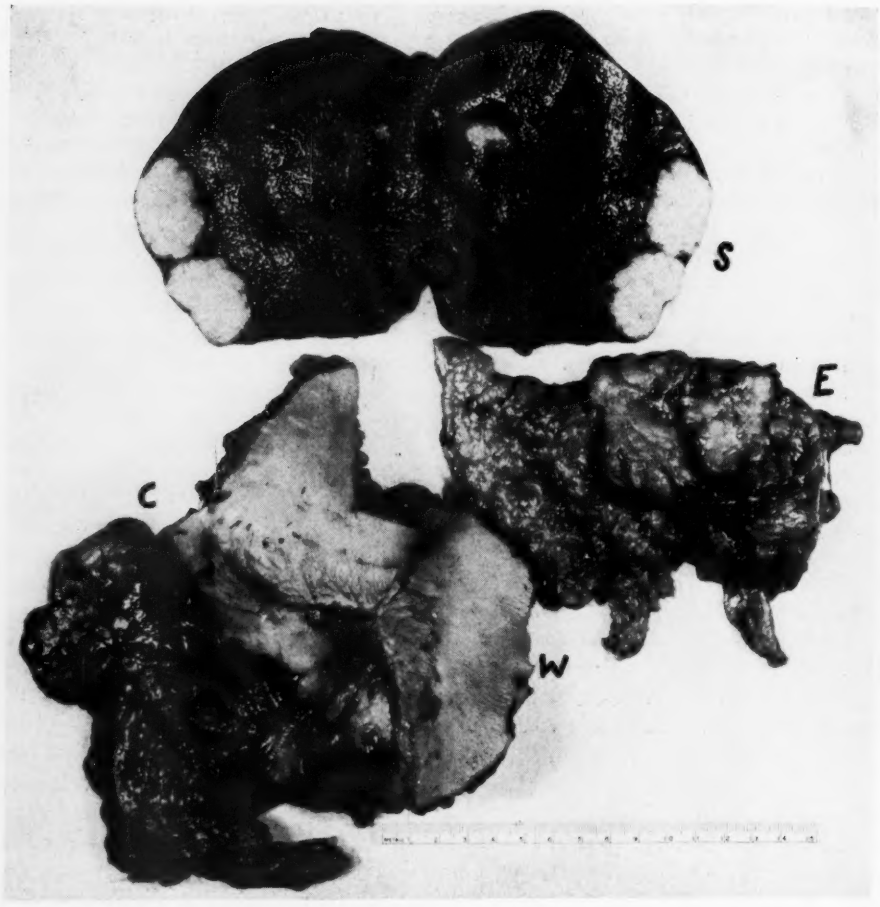

FIG. 4.—Case 5: Photograph of surgical specimen consisting of (S) spleen (bisected) showing three of four metastases from carcinoma primary in descending colon and removed two years previously. (W) Segment of left upper quadrant of abdominal wall and portion of underlying descending colon and omentum, (C) all of which was involved by recurrent carcinoma (a Mikulicz resection had been performed in this region two years previously.) (E) Extension of recurrent carcinoma into areolar tissues in retroperitoneal space of left upper portion of abdominal cavity. Patient living and well, with return to full-time occupation (no colostomy).

en masse at one sitting, one patient succumbed as a result of the operation, a surgical mortality of ten per cent. The results at this writing are summarized as follows:

Patients in whom there was direct spread on to the liver but no discrete metastases:

Case 1.—Living, well, and returned to full-time occupation ..... 5 years
Case 2.—Living, well, and returned to full-time occupation ..... 4 years, 10 mos.
Case 3.—Living, well, and returned to full-time occupation ..... 6 months
Case 4.—Living and ambulatory ..... 4 months

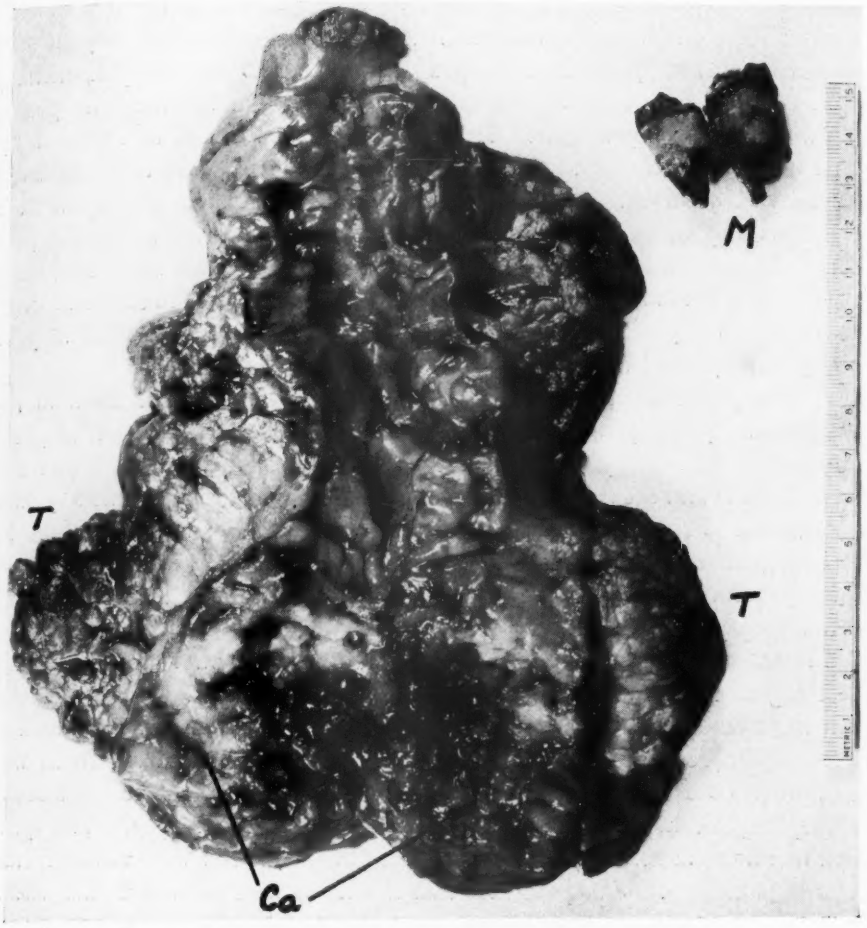

FIG. 5.—Case 10: Surgical specimen consisting of lower sigmoid and upper rectal colon bearing (Ca) carcinoma. (T) Retroperitoneal tissues from concavity of sacrum. (M) Solitary metastasis from anterior surface of right lobe of liver. End-to-end anastomosis of upper sigmoid to lower pelvic colon. Patient clinically well seven months after operation, and returned to usual full-time activities.

Patients in whom there were discrete metastases in liver or spleen:

Case 5.—Living, well, and returned to usual occupation.....7 months
Case 6.—Died of carcinomatosis.....5 months
Case 7.—Died of carcinomatosis.....3 months
Case 8.—Died.....Died 2nd postop. day
Case 9.—Died of carcinomatosis.....5.5 months
Case 10.—Living and well, returned to usual occupation.....7 months

Direct spread of carcinoma onto the liver is obviously of more favorable prognosis than when discrete hepatic or splenic metastases have occurred. The satisfactory immediate results obtained in the patients described above, again, emphasize the fact that such spread is no contraindication to *en masse* excision.

Glisson's capsule serves as an effective barrier to the permeation of carcinoma cells into the liver parenchyma. When extension on to the hepatic surface occurs there appears to develop a considerable inflammatory thickening of the capsule which constitutes a dense barrier through which the neoplastic cells do not readily penetrate. Thus, apparent involvement of the liver by direct extension does not usually constitute the serious spread that might appear to have occurred. Indeed, when the surgical specimens are studied the neoplasms may be readily peeled away from the liver surface. Such a procedure at operation would not be justified, however, because some neoplastic cells might be left *in situ* adherent to the liver. It is preferable to excise through uninvolved liver parenchyma wide of adhesion of the neoplasm; this may be readily accomplished without undue hemorrhage.

At this point, mention may be made of the fact that on occasion in the presence of a primary neoplasm in an abdominal viscus the surgeon may encounter a small solitary nodule in the liver; the first impression is that this is a metastasis and the management of the primary growth is governed by such impressions. Frequently these nodules are not metastases but fibromas, scirrhous angiomas, or cysts. Thus, before final decision in regard to the nature of the procedure for the primary growth excision of the nodule and frozen-section biopsy is indicated.

Metastases to liver or spleen occur as the result of tumor emboli reaching these organs *via* the blood or lymphatic circulatory systems. The presence of such metastases, macroscopically visible, would suggest that other emboli of microscopic size have been seeded elsewhere in the liver and spleen as well as in other locations, although this might not have occurred since instances of solitary hepatic metastasis are not extremely rare at necropsy. The question, therefore, arises as to whether excision of the one, or few, visible metastases is justifiable. It may be said that if one, or few, metastases are visible there may be others deeply situated within the liver which would escape detection and, therefore, remain *in situ* and continue to develop. In favor of excision of visible metastases when they are solitary, or few, the following may be said: Some neoplasms develop slowly. In any given patient it is not possible to know how rapidly the neoplasm is developing nor how rapidly metastases are growing and being dessiminated. It is not a very unusual experience to observe patients survive for relatively long periods after one, or few, hepatic metastases have been observed, but left *in situ,* if the primary growth is resected for palliation. Therefore, excision of all macroscopic neoplastic tissue affords the full benefits of surgical therapy since there is no other treatment available. There is little experience to indicate whether or not such procedures would be worth while, and in the absence of final evidence that they are not, as would seem to be the implications from theoretic considerations, it would appear that there are no contraindications to an attempt to determine the answer on the basis of actual trial, inasmuch as the additional steps involved in excision of the metastases at the time the primary growth is

removed, do not constitute an added procedure of appreciable magnitude, in the properly selected patient (Fig. 6).

SUMMARY

In ten patients with primary malignant neoplasms in various abdominal viscera and with direct spread of one, or few, metastases into the liver or spleen the primary growths were excised *en masse*, with the direct extensions on the liver or with resection of the discrete metastases that were visible. The immediate surgical mortality was ten per cent (1 patient).

The best results were observed where the neoplasms had spread onto the liver and where discrete metastases were not present. It is suggested that increased palliation might have been achieved in some instances where metastases were excised but sufficient time has not elapsed for more definite confirmation of this impression.

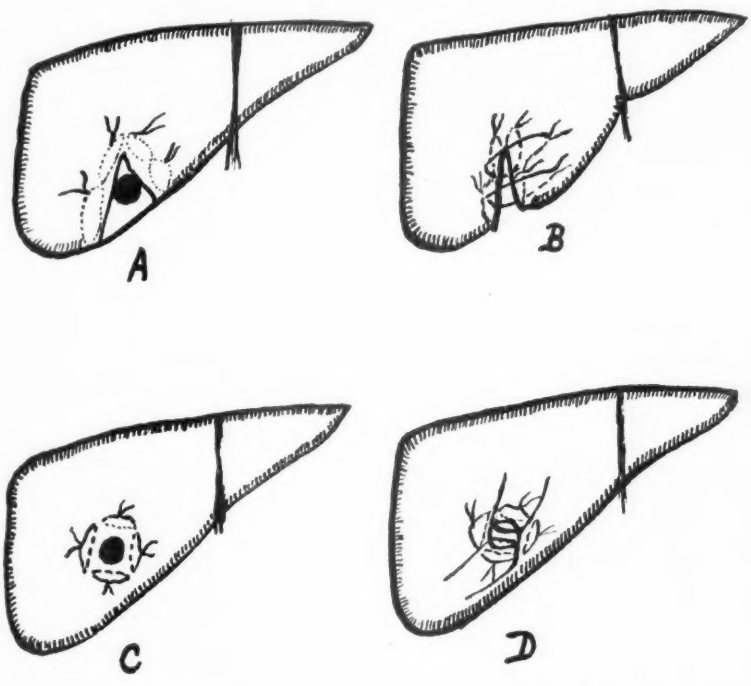

FIG. 6.—Diagrammatic illustration of methods for excision of metastatic masses in liver.
(A) Showing wedge-shape excision of segment of liver containing a metastasis. Mattress sutures inserted and tied before excision is carried out.
(B) Closure of defect in liver after excision.
(C) Metastasis away from margin of liver. Four mattress sutures inserted and tied before excision.
(D) Circular defect in liver collapsed by mattress sutures.

In selected cases, such procedures may be carried out as they represent the maximal effort that surgery might afford, *i. e.*, the removal of all macroscopic evidence of neoplasm, when there is no other form of treatment now available.

DISCUSSION.—DR. DALLAS B. PHEMISTER, Chicago, Ill.: This is extreme surgery which Doctor Brunschwig has presented and it may easily be carried to too great extremes, as in case of excision of liver metastases. Nevertheless, it represents a real advance in both palliative and curative treatment of extensive malignant disease. Surgical principles must be utilized to the fullest in support of the circulation which is usually severely taxed. Both the theory of the cause of the embarrassed circulation and the methods of treating it are tested by these operations.

Because of the abundant sympathetic and vagal nerve supply to the upper abdomen it has been held that operations in this region are especially prone to cause circulatory failure as a result of nerve impulses arising from the trauma. However, it has been found that if, simultaneously, the great blood loss is compensated for by blood transfusion and the water loss by saline infusion, the operations are practically as well tolerated as are similarly managed operations in other parts of the body, while failure to replace blood and fluid loss results in circulatory failure. The reports of Stewart and Warner, Emerson and Ebert and Churchill reveal that extensive blood loss was the important cause of circulatory failure in war wounds of all parts of the body.

Since continuous spinal anesthesia is employed in most of these operations, the claim has been made that the anticipated shock is prevented by the blockage of nociceptive nerve impulses. However, some of them have been done under inhalation anesthesia with almost the same results. Also, the transthoracic resections performed for carcinoma in the upper abdomen are equally traumatizing and they show no predisposition to shock from nerve stimulation although all are done under inhalation anesthesia.

I believe that a study of these results will help to put an end to a chapter of imaginative writing on the great importance of nerve impulses as a cause of circulatory failure from operations in this and other fields.

DR. ALEXANDER BRUNSCHWIG, Chicago, Ill. (closing): An efficient blood bank must be available if massive resections for advanced cancer are to be undertaken. I need not go into the value of whole blood in the treatment of shock.

The question of surgery in advanced carcinoma, especially of the types presented, brings up the whole problem of immunity to cancer. If one injects an animal with certain types of transplantable tumors, removes the growth after a period and then reinoculates it, the second implant will not grow, or grows much more slowly. When a primary growth is removed the human patient may do very well for a number of years and then suddenly succumbs to an explosive development of metastases. I had one patient who had a melanoma of the eye resected 25 years previously. On admission, the complaints were of only six months' duration; prior to that time he was very active in every way. At necropsy, his entire body was found to be riddled with melanoma metastases. Some factor apparently held the widespread disseminated tumor cells in check for a number of years. An important point to consider in connection with patients of the type presented here is whether, after removal of all large macroscopic evidences of tumor, there may not be a degree of immunity sufficient to restrain growth of microscopic masses of neoplastic cells.

DEFINITIVE SURGERY OF THE LARGE INTESTINE FOLLOWING WAR WOUNDS

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AT THE TIME of World War I modern colon surgery had reached only its first great milestone. The contributions of Heinecke, Block,[1] Paul,[2] and Mikulicz,[3] resulting in the development of the Paul-Mikulicz technic had allowed surgeons of that day to attack the diseases of the colon with some chance of success. However, surgeons prepared only with a surgical technic and without modern chemotherapeutics and antibiotics were unable adequately to cope with the casualties sustaining wounds of the colon or rectum in that war. Wounds of the colon constituted 22% and wounds of the rectum 2.4% of all the intra-abdominal visceral injuries in the United States Army in World War I, and carried a mortality rate of 59.6% and 45.19%, respectively.[4]

Complete statistics are not yet available for World War II but it is safe to state that one of the most impressive achievements of the military surgeon will be in the lowered mortality rates for intra-abdominal wounds in general, and particularly wounds of the colon and rectum. It is reasonable to expect that when the final figures are published the mortality rates for these three types of wounds may approach one-third the rate in World War I.

The many factors contributing to these favorable results have received ample publicity and description. The use of sulfonamides, penicillin, plasma and blood transfusions, rapid evacuation and prompt treatment at forward medical installations have all received due credit. However, one of the most important factors in reducing the death toll of colon and rectal wounds has not received its due recognition, namely, the routine establishment of a temporary colostomy in all wounds of the colon, rectum, and certain perineal and buttocks wounds.

Shortly after the close of the North African campaign the Surgeon-General[5] had the wisdom to issue a directive that all wounds involving the large bowel should be exteriorized, if possible, as a temporary colostomy, otherwise sutured and a proximal colostomy established, and in certain perineal and buttocks wounds it was directed that a colostomy be performed as adjuvant to wound healing and secondary suture. The strict adherence to this directive has mate-

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rially contributed to the reduction in both the mortality and morbidity of wounds of this nature. This technic coupled with chemotherapy and modern supportive measures saved the lives of many grievously wounded soldiers. However, this materially increased the cases requiring definitive surgery of the colon and rectum. Many of these cases required multiple operations before they could be restored to normal life. Although many colostomies were closed overseas, a large number of these cases, particularly those with more extensive injuries were returned to General Hospitals in the United States for definitive surgery.

The material on which this paper is mainly based consists of 96 consecutive cases requiring large bowel surgery admitted to the Septic Surgery Section of Rhoads General Hospital, Utica, New York (Table I).

TABLE I

TYPES OF LESIONS ENCOUNTERED IN 96 CASES OF WOUNDS OF THE LARGE INTESTINE REQUIRING DELAYED REPARATIVE SURGERY

Type of Lesion	No. of Cases
Temporary colostomy:	
Simple exteriorization	35
Proximal defunctioning	46
Fecal fistulae:	
Traumatic colostomy	5
Surgical (cecostomies for damage to cecum or terminal ileum)	7
Following extraperitoneal closure of colostomy elsewhere	7
Trans-sacral rectal perforation	9
Ileostomy and Ileocecostomy	6
Laceration of anal sphincter	7
Rectovesicocutaneous fistula	5
Complete colonic obstruction	2

THE PROBLEMS OF REPARATIVE SURGERY OF THE LARGE BOWEL

The patients included in this series form a representative group of all casualties admitted for large bowel surgery. They varied in age from 18 to 35 years. Prior to sustaining their wounds they had all been classified as fit for full field service.

The average length of hospitalization overseas prior to admission to Rhoads General Hospital was about ten weeks. However, the Medical Department facilities for evacuation of the wounded functioned so efficiently that 5% of these cases were admitted to our service within three weeks of the date they were wounded.

In consequence of this wide variation of the time factor following the date of injury and admission to this hospital, there was a correspondingly wide variation in the general physical status of these patients.

Only ten cases, or 10.6%, showed marked evidence of malnutrition. Only three cases, or 3.2%, showed an hypoproteinemia on admission. However, all cases admitted showed an appreciable weight loss. This varied from ten to 80 pounds. Three of the patients had lost 50% of their body weight by the time of their admission to Rhoads General Hospital. One of the important prob-

lems, therefore, in the management of these cases was that of determining the optimum time to institute reparative surgery. The solution varied with each individual case and depended greatly upon the number, extent, and urgency of the procedures contemplated. As a general rule, however, major surgery was withheld until all clinical and laboratory evidence of malnutrition had disappeared. Whenever possible, the patient was carefully managed until he regained all but ten pounds of his former body weight.

FIG. 1

FIG. 2

FIG. 1.—Case 50: Showing two antimesenteric colostomies of transverse colon.
FIG. 2.—Case 50: Same patient as in Fig. 1, following consecutive closure of both colostomies.

Any attempt to convey by verbal description the composite picture presented by these patients as a group upon admission, to those who did not deal with casualties, is impossible. Even the attempt to classify the problems encountered is unsatisfactory; however, two outstanding features characterized this group as a whole. The wounds were extensive. There was a multiplicity of lesions. Because of these factors a case frequently fell into two or three descriptive categories. As a result, no single category contains a large number of cases. Therefore, for the purposes of discussion, we have chosen to describe certain problems only which were matters of concern and which presented interesting surgical conditions.

By far, the most important problem of reparative large bowel surgery was the closure of colostomy (Table I). From the standpoint of the number of cases involved, the future comfort and welfare of the patient, and the application of our work to civilian surgery, the problem of the most satisfactory method of closing a temporary colostomy occupied the place of chief impor-

tance. A total of 86 colostomies are reported in this series. We will deal at length hereafter with the method of closure and results obtained.

Multiple or Secondary Colostomies: Closely associated with the problem of colostomy closure was the management of those cases who had two colostomies, or an ileostomy and a colostomy (Figs. 1 and 2).

There were six such cases in this series. Two secondary colostomies were established following the admission of the patients to Rhoads Hospital. A secondary colostomy was performed when the initial colostomy failed to function properly, or when complete diversion of the fecal stream was paramount and not achieved by the former colostomy, or proximal to traumatic colostomies with extensive damage to the colon and abdominal wall. In this latter type of injury it was felt that the reconstructive surgery would be of such an extensive nature that defunctionalization of the colon containing the traumatic colostomy was essential. Case 1 illustrates this type of management. When definite indications for secondary colostomy are present, it is the opinion of the authors that it should be performed unhesitatingly. The advantages which will be obtained outweigh the disadvantages of additional surgery; the total morbidity will be decreased and superior end-results obtained.

Case No. 1.—This 21-year-old soldier was admitted to Rhoads General Hospital on November 15, 1943. History on admission revealed he sustained a machine gun bullet wound of the abdomen on September 16, 1943. The bullet penetrated the left lower quadrant, where it was shattered. Some of the fragments perforated the sigmoid colon and others fractured the left ilium. Patient lay on field for six days after he was wounded before he was found and taken to a clearing station. Celiotomy revealed that he had a huge intra-abdominal abscess which, when evacuated, resulted in the development of a traumatic colostomy of sigmoid colon.

Examination on admission revealed malnutrition. In the left lower quadrant, just above the middle of the inguinal ligament, was a granulating, infected wound extruding fecal matter. The sides and floor of this wound consisted of sigmoid colon. Just below this wound was a subcutaneous abscess which crossed the entire lower abdominal wall. There was also limitation of flexion, internal and external rotation of the left hip. Roentgenologic examination showed a comminuted fracture of the left ilium involving superior lip of acetabulum, with osteomyelitis.

Shortly after admission, patient developed malaria, which responded promptly to atabrine therapy. Because of his weakened condition and underweight, he was placed on high protein, high caloric and high vitamin diet.

On January 27, 1944, under sodium pentothal anesthesia, the lower abdominal wall abscess was incised, drained and allowed to granulate from the base. Healing progressed satisfactorily and by February 8, 1944, wound was completely healed. The traumatic colostomy decreased in size, but it was apparent it would not close spontaneously. Accordingly, on February 18, 1944, an excision of scar at lower border of wound was performed, revealing a sinus tract beneath the lateral edge of the lower third of the wound, which communicated with site of fracture of the acetabulum. The problem of closure was now considered. Because of the large defect in the abdominal wall surrounding this wound, it was felt that closure of the traumatic colostomy was inadvisable. It was also felt that the osteomyelitis of the acetabulum could not be cleared up until the fecal stream discharging into the wound could be eliminated. Therefore, on March 27, 1944, under spinal anesthesia, a secondary double-barrelled, transverse colostomy was performed, thus diverting the fecal stream from the descending and sigmoid colon.

Sequestrectomy of the left ilium through a clean incision on the left thigh over the capsule of the hip joint was performed on April 25, 1944 under spinal anesthesia. The wound was packed, and healed satisfactorily. However, the sinus tract extending medially into the colon persisted. It was then decided that the traumatic colostomy was keeping the sinus tract open and the osteomyelitis active, despite the fact that no fecal matter was present. Accordingly, on June 7, 1944, under general anesthesia, a closure of the sigmoid, traumatic colostomy was performed. The abdominal wall closure, by necessity, was incomplete, resulting in a defect 7 x 6 cm. extending down to the peritoneum. The wound healed rapidly by granulation from the base, but permitted the development of a small ventral hernia. The sinus tract closed shortly thereafter, and the osteomyelitic process subsided completely.

On July 11, 1944, under spinal anesthesia, a closure of the transverse colostomy was performed. His convalescence was satisfactory, and his bowel function was entirely normal.

Repair of ventral hernia was postponed in view of the extensive surgery this patient had been subjected to in the past six months.

Fecal Fistula: The repair of persistent large bowel fistulae is a common difficult problem following war wounds. A total of 14 persistent fecal fistulae were included in this series, as shown in Table I. Seven of these cases were the result of unsuccessful attempts at closure of colostomy overseas by the extraperitoneal method. The others were the result of surgical and traumatic cecostomies, traumatic colostomies and rectal perforations, as illustrated by Cases Nos. 1 and 5. These presented most difficult problems in surgical judgment and management. The rationale in the management of all fecal fistulae was the same as for colostomy closure, as illustrated in Case No. 5.

Case No. 5.—This officer was wounded on July 5, 1944, by a rifle bullet, point of entrance above right iliac crest, point of exit left flank. Celiotomy performed shortly after injury revealed multiple perforations of jejunum, ileum, severe laceration of sigmoid colon; and laceration of the left ureter.

At operation, a small portion of severely injured small bowel was resected and end-to-end anastomosis accomplished. The multiple perforations of small bowel and the laceration of the sigmoid colon were sutured, and a loop of transverse colon was brought out through the upper end of celiotomy incision to establish a colostomy. However, when the wound was redressed within the next 48 hours, the transverse colon had retracted into abdominal cavity, and thus a temporary colostomy to divert fecal stream was not accomplished. This failure to sidetrack the fecal stream resulted in the breakdown of the repair of the sigmoid colon with the formation of a fecal fistula through the wound of exit.

Through this wound a urinary fistula also drained. A ureteral catheter was placed into the left ureter for treatment of the urinary fistula. Following this the urinary fistula healed, but the fecal fistula persisted.

Admitted to Rhoads General Hospital in November, 1944. On admission patient's general condition was fair. He was having a few bowel movements by rectum each week, but the major portion of the feces passed through the fistula in the left flank.

The physical examination was essentially negative except for severe excoriation at site of fistula and a small incisional hernia at the upper angle of the celiotomy scar.

Laboratory findings on admission revealed a severe urinary infection. Colon organisms were cultured. This responded promptly to oral sulfadiazine therapy. Intravenous and retrograde pyelography revealed no evidence of the previous ureteral fistula.

A cecostomy was performed on December 4, 1944, preparatory to repair of patient's sigmoid colon.

Ten days later, the abdomen was explored and the sigmoid colon found densely adherent to the left iliac fossa. This was partially freed, the fecal fistula was exposed, the margins of the fistula were excised and a transverse closure of the bowel accomplished.

Seventeen days later the cecostomy tube was removed and the following day the patient had a normal bowel movement. Within five days the patient's wounds were completely healed; however, he had persistent abdominal cramp-like pain and diarrhea.

Barium enema, January 23, 1945, showed a marked narrowing of sigmoid colon, just below the site of the fecal fistula. This had not been observed at time of operation.

The hernia noted at the wound of exit in the left flank was repaired on July 16, 1945, and, also, at that time the entire sigmoid colon was freed from the left iliac gutter.

Barium enema following this procedure showed an increase in the caliber of the sigmoid colon. The patient's symptoms of diarrhea and cramp-like abdominal pain were markedly alleviated. He was able to eat all types of food, except those containing large amounts of roughage, milk and milk products, and regained his normal weight.

Trans-sacral Perforation of the Rectum: Nine cases had penetrating wounds of the rectum produced by a missile perforating the sacrum or sacrum and coccyx. Several of these were among the most trying cases with which we had to deal. Two of these cases healed spontaneously under proper management. In both cases, a proximal colostomy completely diverted the fecal stream. In one of these, a secondary colostomy was performed following admission because the initial colostomy failed to accomplish this. No further treatment was necessary. The second case had a defunctioning proximal colostomy on admission, but the fistula persisted. Perforated capsules of sulfaguanidine were inserted into the distal loop, using one gram three times a day. The distal loop was irrigated daily with acriflavine, one to ten-thousand, using 500 cc. three times a day. Externally, wet dressings of penicillin were applied. On this regimen, the fistula closed two weeks after admission. These two cases were the exceptions. The majority did not close spontaneously. There were several reasons for this. Most of these cases developed an osteomyelitis of the sacrum or coccyx. Closure of the fistula occurred only after the removal of the infected bone. A second factor in these trans-sacral fistulae was the marked tendency of the rectal mucosa to eversion and proliferation, in front of the sacrum and along the sinus tract. In one of our cases, fully one-third of the circumference of the rectal wall was destroyed, leaving a large defect. Three operations were necessary to repair this defect, following which his colostomy was closed (Fig. 3).

The successful surgical closure of trans-sacral rectal defects requires three steps that are important. The first is excision of the coccyx and as much of the sacrum as is safely permissible and necessary to allow adequate exposure. Secondly, it is important to achieve as much mobilization of the rectum as possible, both laterally and in front of the sacrum. Finally, and most important of all, is the interposition of some fat or muscle tissue between the portion of rectum containing the transverse closure and the sacrum before closing the skin. Complete hemostasis should be obtained and the wound closed tightly without drainage.

Rectovesicocutaneous Fistulae: One of the most complicated types of wounds encountered were those in which complete perforation of the lower pelvis produced a rectovesicocutaneous fistula (Fig. 4).

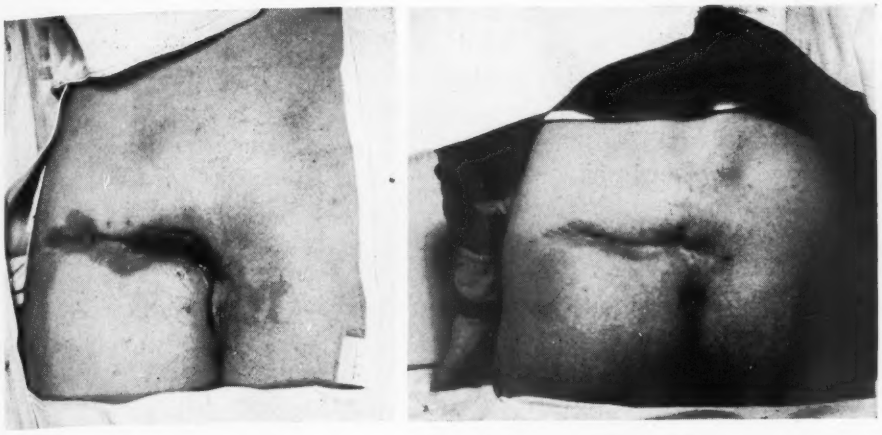

FIG. 3-A

FIG. 3-B

FIG. 3-A.—Case 46: A trans-sacral perforation of the rectum with defect involving one-third circumference of posterior rectal wall. Taken after first operation, (removal of sacral sequestra).

FIG. 3-B.—Case 46: Postoperative view of same patient.

FIG. 4.—Case 15: Rectovesicocutaneous fistula showing suprapubic cystotomy and proximal colostomy.

However, if properly managed, these wounds healed surprisingly well. Cardinal points in their management were a completely defunctioning proximal colostomy and a satisfactory suprapubic cystotomy in conjunction with an indwelling urethral catheter. If these two operative procedures were carried out promptly and satisfactorily, the communication between the rectum and bladder usually healed spontaneously, as did the communication between the bladder and abdominal wall.

All vesicocutaneous fistulae also healed spontaneously except in one case where there was marked loss of substance of the anterior abdominal wall. However, these patients were subject to many complications. The most disturbing complication was an extravasation or spilling of urine in the neighboring wounds, with resulting sinuses and their sequelae. A moderately severe cystitis occurred in most cases and resumption of normal urination was frequently accompanied by a most annoying epididymitis.

Marked Destruction of Large Intestine with Loss of Substance: Some cases showed marked damage of the bowel with a resulting loss of considerable substance. This type of injury predominantly occurred in the cecum; however, Case No. 24, which will be described later (Fig. 7), showed marked loss of the descending colon and Case No. 7, partial loss of the sigmoid colon.

Marked damage to the cecum frequently necessitated the exteriorization of the cecum and terminal ileum as an ileocecostomy. (Case No. 57.) A careful examination of the exteriorized bowel usually showed extensive damage at the ileocecal junction. Often, two, three, or more large rents were present in this area. In one case, the ileocecal valve was completely destroyed. In these cases an attempt to restore the normal anatomic relationships was either impossible or too uncertain to be justified by the expected end-result. Therefore, a proximal ileotransverse enterocolostomy, using a side-to-side anastomosis with resection of the cecum and ascending colon, was the procedure of choice. These cases all showed an excellent end-result. The repair of wounds of the large bowel with loss of substance was greatly facilitated or made feasible by the use of the open anastomosis technic, to be described later.

Case No. 7.—This 33-year-old soldier was injured October 10, 1944, by rifle bullet, point of entrance left buttock, point of exit, suprapubic region. Celiotomy shortly after injury revealed perforations of the liver, terminal ileum, sigmoid colon and bladder. The perforated sigmoid colon was exteriorized because of marked loss of substance of the antimesenteric wall of the bowel; and a double-barrelled ileostomy and suprapubic cystotomy were performed. Patient was treated symptomatically, including plasma and whole blood, and his postoperative course was uneventful.

Admitted to Rhoads General Hospital January 24, 1945; his general condition was reasonably good, but somewhat emaciated. Chief complaint was severe excoriation around his ileostomy.

Examination revealed yellowish discoloration of the skin due to atabrine suppressive therapy. The abdomen was scaphoid. The right lower quadrant presented a well-functioning double-barrelled ileostomy; around the stomata the skin was markedly excoriated and tender. In the left lower quadrant was a simple antimesenteric colostomy. In the midline was a partially healed cystotomy, from which a small amount of urine escaped. Other injuries and physical findings were noted but are irrelevant.

The excoriation of the abdominal wall was promptly controlled with aluminum paste, and the patient's general condition and nutrition showed rapid improvement. All necessary laboratory work (including barium enema, G. I. series, blood studies and total serum proteins) was done.

Patient was prepared in routine manner for colostomy closure, which was accomplished on March 21, 1945.

The operation presented a technical difficulty in that a loop of the ileum was intimately fused to the site of the colostomy necessitating resection of a segment 6 cm. long. The continuity of ileum was reëstablished by end-to-end anastomosis. The colostomy was closed by routine technic as described for the lateral type. The postoperative treatment was routine, and his course uneventful.

FIG. 5.—Case 57: Ileocecostomy performed for marked damage to ileocecal valve and terminal ileum. Wound of entrance also shown.

On April 27, 1945, the ileostomy was closed by end-to-end anastomosis. The preoperative and postoperative care were routine. His postoperative course was uneventful.

Postoperative G. I. series and barium enema showed satisfactory anastomosis, both in sigmoid colon and terminal ileum.

Upon discharge, his physical and mental status were good. All the wounds were healed; he was having regular, normal, daily bowel movements and was completely asymptomatic.

Case No. 57.—This 21-year-old male was injured by machine gun bullet September 26, 1944, (France). Bullet entered right lumbar area, and made its exit through anterior abdominal wall. He was evacuated to a Field Hospital, where an exploratory celiotomy revealed a traumatized lower edge of right lobe of liver, multiple perforations of the ileum and perforated cecum. A resection of a portion of the traumatized ileum and end-to-end

anastomosis were accomplished. The extreme portion of the terminal ileum and the cecum were so lacerated that they were exteriorized as an ileocecostomy (Fig. 5).

On admission to Rhoads General Hospital chief complaint was excoriation of abdominal wall about the ileocecostomy, which was promptly controlled by aluminum paste.

Examination revealed an ileocecostomy in the right lower quadrant. There were three openings in the terminal ileum and exteriorized portion of the cecum.

Laboratory studies other than roentgenograms were negative. Barium enema showed normal colon. Instillation of barium into terminal ileum showed a constant constricting defect 15 cm. from the ileostomy.

At operation, January 29, 1945, the cecum and terminal ileum were found to be so badly damaged that it was impossible to reëstablish the anatomic structures of the ileocecal region. Accordingly, an ileotransverse colostomy was performed, anastomosing the terminal ileum proximal to the strictured portion, described in the roentgenogram (Fig. 5), to the proximal one-third of transverse colon. The ileum distal to the anastomosis was transsected. The ileocecostomy was left in place. Patient made an uneventful recovery. Barium enema four weeks later showed a satisfactory anastomosis. On March 5, 1945, the terminal ileum, the cecum and ascending colon were resected. Abdomen was closed without drainage. Postoperative course was satisfactory. Recheck barium enema again showed satisfactory anastomosis.

Upon discharge, bowel function was normal and patient completely asymptomatic.

Foreign Bodies: For the most part, retained intra-abdominal or pelvic foreign bodies found in conjunction with large bowel wounds were asymptomatic. No attempt was made to remove these. The removal became necessary when they were responsible for persistent sinuses leading to the colon, or pericecal, colonic, or rectal abscess or phlegmon. Four cases of this type are included in this series. The removal of a foreign body usually entailed a very difficult surgical procedure. In one case, a large shell fragment lying in the pelvis, between the rectum and sacrum, produced a perirectal cellulitis, causing marked pelvic pain.

Barium enema revealed a rigidly fixed rectum displaced to the right. Overseas, an unsuccessful attempt had been made to extract the fragment by a posterior retroperitoneal approach. On admission to Rhoads Hospital the foreign body was still present. After preoperative preparation, including sulfadiazine, the foreign body was removed by an anterior, transperitoneal route. The patient made an uneventful recovery, following which his colostomy was closed. Case No. 16 illustrates even more vividly the extreme difficulty caused by infections resulting from foreign bodies.

Case No. 16.—This 32-year-old soldier was injured in France July 6, 1944, by a hand grenade accidentally exploding in his rear pocket. He sustained multiple severe wounds of the right and left buttocks, right and left thighs and legs, compound fracture of the left radius and a penetrating wound of the rectum. The following day a sigmoid colostomy was established. However, this colostomy retracted, thus, failing to divert the fecal stream, resulting in the formation of five fecal sinuses in the left buttock. Therefore, a Devine colostomy of the transverse colon was performed on July 27, 1944, following which the patient developed a paralytic ileus which was satisfactorily controlled with Miller-Abbott tube suction. Patient was evacuated by air to the United States and admitted to Rhoads General Hospital.

Upon admission, examination revealed the patient to be pale, exhausted and somewhat emaciated. His general condition was good and the colostomy was functioning satisfactorily.

Roentgenograms taken shortly after admission showed eight metallic foreign bodies

in the pelvic region. Barium enema revealed the barium to flow from the lower rectum about 4.5 inches from the anus to the right around a large foreign body and reënter the rectum proximally, forming a fistulous loop. Therefore, colostomy closure was postponed. Serial barium and skiodan enemas, and sigmoidoscopic studies were performed which showed the fistulous tract to be decreasing in size, and spontaneous closure seemed likely. However, after several months of observation it was still patent; therefore, January 15, 1945, an exploratory celiotomy was performed in an attempt to locate and remove the perirectal foreign body. A careful and thorough search failed, however, to locate it. His postoperative course was uneventful (Fig. 6).

FIG. 6.—Retained metallic foreign body. Sinus tract leads from upper rectum to f.b. and back into lower rectum.

Barium enema five weeks after this operation, for the first time, showed no evidence of a sinus tract leading from the rectum to the foreign body. Apparently, this had closed spontaneously. Repeat barium and skiodan enemas and sigmoidoscopic studies failed to reveal the slightest evidence of the former patent fistulous tract. Therefore, after routine preparation, on May 2, 1945, closure of the Devine-type colostomy was accomplished. His postoperative course was essentially uneventful until the 26th postoperative day. At that time, he presented definite evidence of a deep-seated cellulitis in the left buttock. Five days later, an incision and drainage of an extensive left perirectal abscess was performed. A sinus tract at the bottom of the abscess cavity was probed and found to extend toward the right. Definite origin of this abscess could not be established.

Following this episode, he had recurrent deep-seated perirectal abscesses requiring incision and drainage. On June 29, 1945, a foreign body was removed from the left buttock, with no apparent benefit. There was an associated persistent draining sinus tract in the left buttock. This sinus tract was identified roentgenologically with the aid of lipiodol, skiodan and probe, and found to communicate with the initial fistulous loop and the foreign body

on the right side of the rectum. It was very apparent at this time that the fistulous tract had probably reopened and that the draining sinus and recurrent perirectal abscesses could be cured only by removal of the underlying etiology, namely, the foreign body. Therefore, on November 21, 1945, an exhaustive localization was done. Cystography was performed to study the relationship of the full bladder to the rectum and lipiodol instilled into the sinus tract to study their relationship to the foreign body. Vertical and transverse wires were also used, in addition to five metal numerals arranged in a square formation, with the fifth in the center. Finally, when the exact location and depth of the foreign body was known, a long skin needle corresponding to the depth of the foreign body, threaded with silk, was passed down to the foreign body so that the eye portion of the needle was just beneath the skin. Roentgenograms showed the point of the needle to just reach the upper edge of the foreign body in the right pelvis. In view of the absolute localization and the danger that the needle might have passed through some important structures, the patient was immediately taken to the operating room with needle in place. This time, an incision was made through the right buttock. This was carried down, using the needle as a guide, the point of which was known to be directly on the foreign body. The foreign body was located on the anterior, left, lateral aspect, at the level of the lower and middle-third of the rectum, and removed. The postoperative course was entirely uneventful. The constant, tender, painful induration of the left buttock promptly subsided and the persistent draining sinus closed completely.

Laceration of the Anal Sphincter: Extensive laceration of the anal sphincter was encountered in seven cases. These required multiple operations to repair. The value of the completely defunctioning colostomy was readily apparent in these cases. Because of the absence of fecal contamination these plastic repairs healed almost as well as clean wounds. Despite extensive loss of sphincter substance it was possible to restore satisfactory function in all cases. The technic which we employed can briefly be described: A semicircular incision paralleling the anal orifice about 3 cm. from the mucocutaneous junction was used. The sphincter was approached, scar tissue excised and the severed ends mobilized, and the defect closed with mattress and interrupted sutures of chromicized catgut. If the defect could not be closed it was reduced as much as possible by anchoring the free ends, and the wound was closed. After several weeks of dilatation and sphincter control exercises a second operation was performed in a similar manner. It was then possible to unite the severed ends. When more than one interruption of the sphincter was present, one trans-section was repaired at a time. The importance of sphincter control exercises and rigid adherence to daily dilatation cannot be too strongly stressed.

In the surgical management of cases with colostomy and anal sphincter injury or repair, it is of essential importance to test the sphincter action and control before the colostomy is closed. This may be simply accomplished by the instillation of commercial starch in water into the distal loop or rectum, or both, and observing the sphincter control and power of interruption.

It is disturbing, to say the least, to both surgeon and patient to recognize an inadequate sphincter following colostomy closure. It is an inexcusable mistake which can and should be avoided.

Marked Loss of Substance of the Abdominal Wall: This serious complication was encountered in four cases. In two cases, following the closure

of colostomy, it was impossible to repair the loss of abdominal musculature, and only the peritoneum could be closed. Later, plastic procedures were carried out to repair the abdominal wall defects. (See Case No. 24 below.) One case was sent to a Plastic Center for repair of marked loss of the lower abdominal wall which prevented closure of vesicocutaneous fistula. The fourth case had a severe vesico-ileal fistula which communicated with an abscess extending beneath Poupart's ligament to the right hip joint. The anterior two-thirds of the bladder were completely exposed. An ileotransverse enterocolostomy was performed successfully, side-tracking the vesico-ileal fistula.

Associated Intestinal Obstruction: In an earlier paper two of the authors[6] have presented the problem of intestinal obstruction as a late complication of war wounds. This was a complication in nine cases included in this series, all of which occurred before colostomy closure at Rhoads General Hospital. As shown in Table II, five cases showed incomplete small bowel obstruction. These were treated by duodenal suction-decompression, with recovery. In all cases, partial obstruction was proven at subsequent operation; performed either for closure of a colostomy, or for repeated episodes of partial obstruction. In three of these cases, the small intestine was found intimately adherent to the colon and anterior abdominal wall at the site of exteriorization of the colostomy. Two cases had complete small bowel obstruction. One of these cases (Case No. 24) obstructed on two occasions before an extensive traumatic colostomy and secondary colostomy could be closed.

Case No. 24.—This 30-year-old soldier was wounded in Germany, March 12, 1945, by a high explosive shell fragment. He sustained a severe wound of the left flank, with marked loss of substance of the lateral abdominal wall. The wound was débrided shortly after injury and it was the opinion of the operator that the peritoneal cavity had not been entered. His postoperative course was fulminating, and, on the 8th postoperative day, there occurred the spontaneous rupture of a fecal abscess through the wound in the flank. Examination revealed marked destruction of the proximal descending colon. The following day, a proximal transverse colostomy was performed and the patient promptly improved (Fig. 7).

Twenty-eight days after injury, this soldier was evacuated by air to the United States and admitted to Rhoads General Hospital, April 9, 1945. Upon admission, he appeared toxic and exhausted, and complained of nausea and moderate cramp-like abdominal pain, His colostomy had not functioned for 24 hours. Following the instillation of oil into the proximal loop of his colostomy he had a copious evacuation and all symptoms disappeared.

At 1 P.M. on the following day he complained of cramp-like abdominal pain of increasing severity. This was followed by nausea, vomiting, very slight abdominal distention, and moderate tenderness in the left upper quadrant. Blood studies were taken, two hours after onset of this episode, which showed: white blood count—16,000; differential—not remarkable; sedimentation rate—44 mm. per hour; total protein—5.85%; hematocrit—31 mm. A plain film of the abdomen showed several markedly distended loops of small bowel. The pain and distention progressively increased. Wangensteen duodenal suction and intravenous fluids were started, and the patient was scheduled for operation. At 7:30 P.M., ten minutes before being taken to the operating room, he gagged on the nasal suction tube. The resulting increased intra-abdominal pressure caused extrusion of several loops of small intestine through the large wound in the left flank, which had been sealed-off by the traumatic colostomy of the descending colon.

Celiotomy was performed immediately. Three markedly dilated, discolored loops of lower jejunum, densely plastered together, were found incorporated in a mass of adhesions. In addition, four other loops were found to have been extruded through the large opening in the flank. The abdomen was closed following the liberation of the bowel obstruction and the replacement of the eviscerated bowel. The defect in the left flank was too large to attempt closure. Therefore, it was overlaid by two folded linen towels and gauze packs, held in place by several retention sutures of braided silk, thus, containing the abdominal contents within the peritoneal cavity. The patient's immediate postoperative condition was good.

FIG. 7-A FIG. 7-B

FIG. 7-A.—Case 24: Traumatic colostomy of descending colon and proximal defunctioning colostomy of transverse colon. Appearance on admission.

FIG. 7-B.—Case 24: Appearance of patient after one-stage operation, resecting descending colon (traumatic colostomy) and transverse closure of proximal colostomy.

Convalescence was uneventful until the 16th postoperative day, at which time a dissecting wound occurred beneath the surgical colostomy which communicated with the wound in the flank. Exploration revealed multiple fecal sinuses in the area because of the retraction of the colostomy. Therefore, May 14, 1945, a revision of the surgical colostomy was performed. On the second postoperative day, patient complained of severe cramp-like abdominal pain and nausea. Examination revealed hyperactive peristalsis and a tinkling bell note just above the umbilicus. A diagnosis of intestinal obstruction was made and confirmed roentgenologically.

Celiotomy was performed immediately. Two angulated loops of small bowel were found densely adherent to the abdominal wall. The obstruction was released; 100,000 units of penicillin in saline were placed in the peritoneal cavity and the abdomen closed in layers without drainage. Plasma, 500 cc. and whole blood, 500 cc. were administered on the operating table. His postoperative course was uneventful until the 18th day, at which time he complained of nausea, anorexia and general malaise. Examination revealed an acutely ill, toxic patient with a moderate icteric tint. Diagnosis of infectious hepatitis was made. The icteric index was 68 and the bromosulfalein test at that time showed 75% retention. Therapeutic measures were instituted until the bromosulfalein test showed no retention.

After the revision of his colostomy all the abdominal sinuses healed. Following barium enema, G. I. series and sigmoidoscopic examination, August 20, 1945, both the traumatic and the surgical colostomy were dissected free from the abdominal wall. The traumatic colostomy was managed by resection of the damaged portion of descending colon and end-to-end anastomosis. The antimesenteric surgical colostomy was closed transversely. The

bowel was replaced within the peritoneal cavity and the abdomen closed without drainage (Fig. 8).

The patient's convalescence was uneventful except that the defect in the left flank did not heal satisfactorily. Therefore, November 5, 1945, the defect was corrected by a plastic repair, including a full-thickness double pedicle graft and a split-thickness graft. Patient made an uneventful recovery.

His end-result was excellent. He regained his normal weight and was completely asymptomatic. He tolerated a regular diet well and had regular, normal bowel movements (Fig. 8).

FIG. 8.—Postoperative barium enema of Case 24. (Same case as in Figure 7.) Showing the result obtained following closure of traumatic colostomy of descending colon and defunctioning colostomy of transverse colon.

Two cases showed complete obstruction of the large bowel. One was due to extreme angulation of the transverse colon with adherence to the anterior abdominal wall following extraperitoneal type of colostomy closure performed overseas. The second case, No. 77, developed obstruction with intussusception of the descending colon due to a large leiomyoma which developed at the site of the spur in a Paul-Mikulicz closure.

This case will be referred to again in discussing colostomy closure. It is interesting to note that no case of either large or small bowel obstruction developed following closure of colostomy or any other large bowel surgery performed at Rhoads General Hospital.

Associated Severe Abdominal Injuries and Concomitant Extensive

Wounds: An attempt to describe all the concomitant severe injuries is beyond the scope of this paper, and will be impossible in the space allowed. All types of severe, multiple, compound, comminuted fractures, osteomyelitis, extensive nerve injuries, chest wounds, *etc.*, were encountered. Table II gives a partial list of these conditions. Sound surgical judgment was needed frequently to decide which conditions warranted surgical preference. As a rule, colostomies were closed before orthopedic surgery was attempted.

TABLE II

ASSOCIATED INJURIES AND RELATED COMPLICATIONS INCURRED PRIOR TO ADMISSION OR DEVELOPED PRIOR TO LARGE BOWEL SURGERY IN 96 PATIENTS

Injury or Complication	No. of Cases	Per Cen
Stomach	6	6.3
Small intestine	30	31.5
Liver	6	6.3
Spleen	2	2.1
Kidney	6	6.3
Bladder	9	9.4
Ureter	2	2.1
Urethra and prostate	4	4.2
Perineum	9	9.4
Fractures	37	38.9
Osteomyelitis and chondritis	15	15.7
Nerve injuries	9	9.4
Thoracic wounds	10	10.4
Intestinal obstruction:		
Small bowel—incomplete	5	5.2
Small bowel—complete	2	2.1
Large bowel—complete	2	2.1

* All cases of intestinal obstruction occurred prior to surgery performed at Rhoads General Hospital.

There was also a multiplicity of associated abdominal injuries which, likewise, cannot be described in detail. These are shown in Table II. It is regrettable that these bare statistics convey little of the drama and wonder of these cases. Such grievously wounded men never before survived their wounds. Prior to this war, cases with similar abdominal wounds would seldom have lived to reach a hospital. Due credit for this achievement must be given to the company aid men's and battalion surgeon's heroic on-the-spot treatment.

By the time these cases reached the General Hospital in the United States, through the normal channels of evacuation, these associated wounds were usually healing or healed. However, their presence markedly influenced the course of treatment. For example, a man who had lost one kidney was considered most carefully before sulfonamides were administered, and watched with great care during the treatment. The presence of extensive, silent retroperitoneal abscesses was another distressing complication in several cases.

Closure of Colostomy: Ever since Paul's[2] classic description of the procedure of colonic exteriorization, published in 1895, surgeons have been engaged in a never-ending search for the ideal way to close a colostomy. This technic was first described by Heinecke in 1890, and the first case in which this method was applied was reported by Block,[1] of Copenhagen, two years later. However, the procedure did not gain widespread acceptance until after the later reports of Paul and Mikulicz. Following the appearance of Mikulicz's[3]

paper on the subject, in 1903, and the erroneous but widespread application of his name to the procedure, many variations of the so-called Mikulicz technic have appeared. The use of this technic has been based on the widespread and until recently justifiable fear of peritonitis resulting from soilage of the peritoneal cavity or leakage at the suture line when intraperitoneal anastomosis was attempted. The extraperitoneal technic remained the only safe procedure in colon surgery until after the advent of the sulfonamides.

In 1940, Marshall[7] introduced a relatively nonabsorbable sulfonamide derivative—sulfanilylguanidine. This was originally developed to treat bacterial disease of the intestinal tract. Due to its low degree of absorbability it was expected to exert a strong local bacteriostatic effect. The application of sulfaguanidine to colon surgery was first recognized by Dr. Warfield Firor.[8] In 1941, he first reported its use in a series of 12 cases prepared for colon surgery. In 1941, Poth[9] introduced sulfasuxidine for a similar use. A renewed interest in primary anastomosis of the large bowel followed. It was shown by Firor,[10] Poth,[11] Allen,[12], Archer,[13] and others, that primary resection and anastomosis of the colon could be performed safely after preoperative preparation with sulfasuxidine. In view of this work, it is becoming increasingly apparent that the extraperitoneal technic is no longer the procedure of choice except in a limited number of cases.

When the first group of colostomy patients were admitted to our service, the various methods used to close a temporary colostomy were carefully considered. Certain dangers inherent in the Paul-Mikulicz closure were recognized. Mayo and Schlicke,[14] in 1942, cited the dangers in crushing a colostomy spur. These are perforation of the bowel by the enterotome, with resulting peritonitis; inclusion of part of the mesentery in the enterotome, with resulting gangrene of the spur and perforation; also, hemorrhage from the colostomy if part of the mesentery is included in the enterotome and jejuno- and ileocolic fistulae resulting from intrusion of a loop of small bowel between the limbs of the spur at the time the clamp was applied.

One further complication of the Paul-Mikulicz type of colostomy closure should be mentioned. In this series, two cases were noted who displayed a complication following the crushing of a spur which we have not seen recorded before. One of these cases (Case No. 77), already mentioned, had a large tumor of the bowel develop at the site of a Paul-Mikulicz closure. This was reported by the pathologist to be a leiomyoma. (Fig. 9.)

A second case was later operated upon for closure of fecal fistula resulting from an unsuccessful Paul-Mikulicz closure. In this case, a similar tumor of smaller size was found. It was easily seen in the second case that the tumor represented an hypertrophy of one side of the crushed spur. It is our opinion that the first case represented an extreme degree of this condition. Bargen,[15] in 1944, reported a total of 806 cases of new growths of the large intestine, including only two leiomyomata. A case illustrating leiomyoma follows.

Case No. 77.—This 34-year-old white soldier was wounded in Italy by an 88-mm. shell

fragment, sustaining a wound in the left costal vertebral angle which traversed his abdomen and made its exit in the left lower quadrant.

A celiotomy performed shortly after injury at the field hospital revealed severe laceration of the left kidney and a perforation of the descending colon. A transperitoneal nephrectomy was performed and a colostomy established by exteriorizing the perforation in the descending colon. Two months after injury the patient's colostomy was closed by Mikulicz technic. For the seven weeks during which the colostomy functioned the patient was exceptionally well. However, three weeks after closure of his colostomy he developed an abscess at the site of closure, the wound separated and a large amount of pus escaped. Following this episode, diarrhea developed which at first consisted of only fluid fecal material. Later, a mucoid discharge was seen and, finally, just before evacuation by hospital ship to the States, his diarrhea became bloody.

FIG. 9.—Specimen removed from descending colon in Case 77, showing leiomyoma at site of Mikulicz closure of colostomy. Arrow indicates lumen of bowel above tumor.

Upon admission to Rhoads General Hospital, on April 14, 1945, he complained of an almost continuous generalized cramp-like abdominal pain, which was most marked along the course of the large bowel. He also complained of a stabbing, recurrent pain in the left upper quadrant just above site of closure of colostomy. He was constantly nauseated and took little by mouth for the week prior to admission. He had 15-20 evacuations daily of a small amount of fluid material per rectum, consisting of mucus and bright red blood. He had not passed feces for several days.

Physical examination was essentially negative except for the abdomen. There was little distention. The cecum, ascending colon and transverse colon were palpable and appeared to be filled with feces. There was marked tenderness directly over the site of his colostomy closure and marked guarding of the entire left side of the abdomen.

All his abdominal wounds were healed. This patient was observed for ten days. During this time his nutrition and fluid balance were maintained by intravenous therapy. Barium enema revealed a mass in the descending colon above what seemed to be an ample anastomosis. Sulfaguanidine was administered orally as usual.

On April 25, 1945, a celiotomy revealed a large intrinsic, pedunculated tumor of the descending colon at the site of the previous colostomy. This was removed by resection of a 14-cm. segment of the descending colon. An end-to-end anastomosis was accomplished. Patient's convalescence was uneventful, except that he developed a recurrent phlebitis of the right forearm. Following this surgical procedure all his gastro-intestinal complaints completely disappeared. He had regular, daily, normal bowel movements and had no difficulty with a regular diet. The postoperative barium enema showed a very satisfactory anastomosis.

The microscopic diagnosis of the colonic tumor was fibroleiomyoma.

We set as our goal the restoration of the colon to as near normal anatomic form and function as possible. Our cases were all young men, with many years of life expectancy. We did not wish to have them handicapped by an improperly functioning colon, or an abdominal wall that was inadequate. Under both of these headings the extraperitoneal closure was found wanting. It leaves the patient with a loop of large bowel permanently incarcerated in the abdominal wall.

Even in the presence of an adequate stoma, many patients who have had extraperitoneal closures experience unpleasant abdominal discomfort from tension on the bowel at the point of incarceration, when the bowel is distended, or during defecation. The occurrence of ventral hernia following extraperitoneal closure is common. Babcock and Bacon,[16] in discussing the complications of a Paul-Mikulicz procedure, stated that it usually leaves a weak abdominal wall or hernia. Our own experience with a large group of cases done by this technic overseas coincides with their observation. Finally, it was our considered opinion that the presence of a loop of colon permanently incarcerated in the abdominal wall offered a likely site for the development of an internal herniation and obstruction of the small intestine.

The advisability of intraperitoneal closure was, therefore, considered. Only two factors weighed against this. It exposed the patient to contamination of the peritoneal cavity and probable peritonitis. It involved a more extensive surgical procedure. In view of our previous experience and the work by Firor and Poth, and others, with sulfonamide preparation of the bowel for colon surgery, it was felt that the first disadvantage could be overcome. Since these patients were mainly young adult males the second objection was of lesser importance and the advantages to be obtained outweighed the prolongation of operating time.

In one of the early patients admitted (Fig. 10), a complete rotation of the exteriorized loop, with transposition of the distal and proximal stomata, was observed. A crushing clamp could not be safely applied to this colostomy. Seven cases in this series showed complete rotation. Since many of these colostomies had been set-up in haste, under field conditions, and since they had been established elsewhere, it was evident that the application of an enterotome would usually be extremely hazardous.

It was, therefore, decided to completely free the exteriorized loop from the abdominal wall and perform an intraperitoneal closure. This technic was

followed in every case admitted to Rhoads General Hospital for colostomy closure.

Sulfonamide Preparation of the Large Bowel for Surgery: Sulfaguanidine was used in preparation of the bowel for surgery. There were several reasons for the use of this drug rather than the newer drug, sulfasuxidine. Vieta and Stevenson,[17] in 1942, had shown it to be adequately effective in inhibiting and killing coliform organisms. Firor, in 1941, had used it successfully, although he later condemned it in favor of sulfasuxidine. We had used it previously in civilian surgery with satisfaction. Sulfaguanidine was a standard item of issue in the Army Medical Department. Sulfasuxidine, although not denied to us, was not an item of issue. After completing this series we can say that the results obtained with the use of sulfaguanidine were eminently satisfactory.

Vieta and Stevenson, Firor and Poth, have all stated that sulfaguanidine is less effective in the presence of large amounts of pus or extensive ulceration

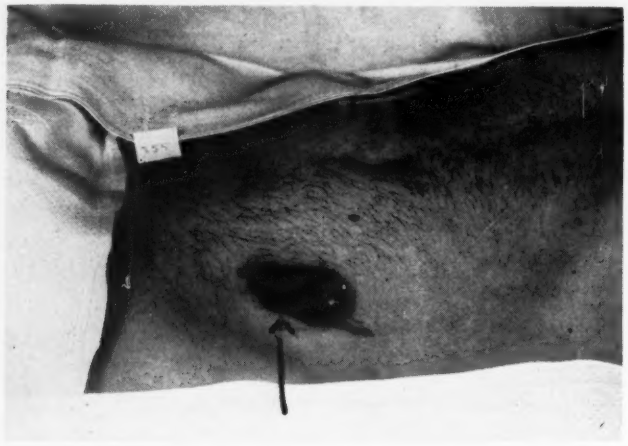

FIG. 10.—Case 46: Illustrating transposition of colostomy stomata. Arrow indicates proximal stoma.

of the colon. This criticism cannot be answered since these two conditions were seldom encountered in these cases. However, Firor and Poth both reported unfavorably on the use of sulfaguanidine on the basis that it had a relatively high degree of toxicity and was not as effective as sulfasuxidine. In our experience this toxicity was not observed. It was administered to about 300 cases, to some for prolonged periods. Only one toxic reaction to the drug, allergic in type, manifested by generalized urticaria, was observed.

It should also be reported that an increased amount of bleeding occurs at operation when sulfaguanidine is used. This was explained by Vieta and Stevenson to be due to a reduction in the level of the plasma prothrombin, by decreasing the number of organisms of the normal intestinal flora, thereby reducing the synthesis of vitamin K. However, if this is true of sulfaguanidine, it should be equally true of sulfasuxidine and sulfathaladine. This

observation led to the administration of parenteral vitamin K to all patients prepared with sulfaguanidine.

The work-load carried by the laboratory of Rhoads General Hospital during the period covered by this series was so heavy that quantitative bacteriologic studies on all cases was not justifiable. However, cultures were taken from the colostomy stomata of 26 consecutive cases at the time of operation. The cultures were taken from the proximal and distal stomata at a depth of at least two inches. Two cultures showed no growth, nine showed an absence of coliform organisms and, in the remainder, coliform organisms were present.

Theoretically sulfasuxidine should be eminently more effective as a non-absorbable sulfonamide than sulfaguanidine in preparation for colon surgery since the absorption rate is 5% and 50%, respectively. However, sulfaguanidine may possess some special antibacterial activity as yet unexplained. The greater absorption of sulfaguanidine may be responsible for greater safety, in that the drug is not only concentrated within the lumen, but also in the wall of the bowel, as well as in all the intra-abdominal tissues. It is interesting to note that, as reported by Marshall in 1940, sulfaguanidine is equally as effective as sulfapyridine in the treatment of pneumococcic infections in mice and only somewhat less effective than sulfanilamide in the treatment of *B.-hemolytic Streptococcic* infections. In conclusion, as to the comparative efficacy of sulfaguanidine, sulfasuxidine and sulfathaladine, it should be clearly understood that no attempt was made to evaluate the advantages or disadvantages of the latter two. However, it is our conviction that sulfaguanidine, although shelved in favor of newer and reputedly more efficacious sulfonamides, is a very efficient and reliable chemotherapeutic agent in the preoperative management of colon surgery. It has served us exceedingly well.

PREOPERATIVE WORK-UP

The preoperative work-up of patients includes the following procedures:

1. A periodic complete blood count and urinalysis.
2. Preoperative determination of blood chlorides and proteins.
3. Roentgenograms of chest.
4. Barium enema and small bowel series.
5. Bacteriologic studies of all open wounds.
6. Sigmoidoscopic examination.

Following admission and during the work-up, patients were put on a low residue, high caloric, high vitamin diet.

In the preoperative work-up of these patients the importance of a barium enema, small bowel series, and sigmoidoscopic examination cannot be stressed too strongly. A small bowel series often revealed areas of fixation of the small intestine which was of importance in prognosis, operative approach and postoperative management (Case No. 57). It revealed congenital anomalies as in Case No. 81, in which the entire small intestine lay to the right of the entire colon, which was entirely confined to the left half of the abdomen (Fig. 11).

The small bowel series frequently showed evidence of severe vitamin deficiency. Barium enema, of course, delineates the continuity of the colon. It reveals before operation whether or not a spur had been set-up. It is particularly helpful in multiple colostomies, as it can be determined thereby whether both colostomies can be closed at a single operation, by removal of the intervening loop and an end-to-end anastomosis. A roentgenologic finding of interest in this regard is that the defunctioned intervening loop between the two colostomies may take on the roentgenographic appearance of small intestine (Fig. 12).

FIG. 11.—Case 81: Congenital anomaly of the colon. Colostomy performed at apex of colonic loop. Extraperitoneal closure overseas. Developed fecal fistula. Closure of fecal fistula at Rhoads General Hospital. Illustration shows preoperative barium enema.

Sigmoidoscopy is of value in determining the patency and degree of healing of the rectum and rectosigmoid, particularly when that portion of the bowel was damaged. It should be noted that when a colostomy is established below the midsigmoid, the distal loop is usually so fixed between the abdominal wall and pelvic peritoneal reflection that it is impossible to advance the scope beyond the angulation at the point where the rectosigmoid leaves the hollow of the sacrum. This is not evidence of obstruction or narrowing and can be so determined by barium enema. It should be noted that this finding may occur in a normal individual without colostomy.

Preoperative Preparation: Ten days prior to the tentative date of closure

the patient was put on a special soft, low residue diet and the following measures initiated:

1. Two grams of sulfaguanidine were administered orally four times a day until the morning of operation.

2. One gram of sulfaguanidine was inserted into the distal loop in two perforated capsules three times a day.

3. The distal loop was irrigated three times a day with 1:10000 solution of acriflavine.

FIG. 12-A

FIG. 12-B FIG. 12-C

FIG. 12-A.—Case 50: Defunctioned segment of colon between two colostomies of transverse colon showing appearance simulating small intestine.
B. Case 50: Barium enema of same patient following closure of distal colostomy.
C. Case 50: Barium enema of same patient after closure of both colostomies.

4. Three days before operation the patient was put on a milk and jello diet with supplemental fluids to maintain a 3,000 cc. daily intake.

5. Vitamin K was administered parenterally in amounts of 2 mg., three times a day, for two days preoperatively.

6. The day before operation the patient received nothing but water by mouth.

7. One thousand cubic centimeters of 10% glucose in distilled water and 500 cc. of plasma, or 30 Gm. of parenteral amino-acids were given intravenously.

8. At 7 A.M. and 3 P.M., he received saline cathartics.

9. At noon and at 8 P.M., both loops of the colon were irrigated with acriflavine until the solution returned clear. This irrigation was repeated at 6 A.M. the morning of operation.

Operative Technic: These cases were usually given gas-oxygen-ether anesthesia. However, spinal anesthesia was used in a fair percentage of the cases (Table III). Following anesthetization, the abdominal wall, including the exteriorized stoma, was prepared with ether, alcohol and tincture of merthiolate or mercresin. A small operative field was draped in the usual manner.

An elliptical incision was made about the exteriorized colonic stoma. This incision was usually made in the direction of, and large enough to include, the old scar. However, when the colostomy had been established through the original celiotomy wound, only enough scar was excised to free the bowel. A cuff of skin and subcutaneous tissue 0.5 cm. in width was left attached to the bowel on either side. By sharp dissection, the incision was then carried down to the fascia, completely around the bowel. By combined sharp and blunt dissection, the fascia and muscles were completely dissected from the colon. The peritoneal cavity was entered with care and the loop of bowel completely freed from the abdominal wall. No fascia or muscle tissue was left attached to the bowel. The loop of colon was then drawn outward upon the abdomen, if possible. The loop was thoroughly inspected to determine whether or not a spur had been set-up and to detect any damage to the bowel in freeing it from the abdominal wall. The free peritoneal cavity was protected by sponges. If the colostomy was the simple antimesenteric type without a formed spur, or with a spur which could easily be broken down without injury to the bowel or embarrassment to the circulation, the skin cuff was then excised from the edges of the stoma. The everted mucosa was freed and replaced, the edges of the defect freshened and a simple transverse closure effected, using an inner continuous Connell suture of No. 000 chromic catgut and an outer layer of interrupted fine black silk sutures (Fig. 13).

If the colostomy displayed a complete transection of the bowel, or if a very firm and extensive spur was present, both ends of the bowel, including the complete spur, if present, were resected. It should be emphasized that it is necessary to resect any spur which cannot be satisfactorily broken down. To leave in a fixed spur at the site of closure results in a rigid defect with faulty

peristalsis and a narrowed lumen, and produces malfunction and unpleasant abdominal symptoms.

An end-to-end anastomosis was then performed, using an inner continuous suture of No. 000 chromic catgut and an outer layer of interrupted fine black silk sutures. In the first 12 cases of end-to-end anastomoses, a Furniss clamp was used to accomplish a closed anastomosis. However, the inconsistency of operating in the field of an open colostomy stoma and then doing a closed

FIG. 13-A

FIG. 13-B

FIG. 13-A.—Temporary colostomy performed by simply exteriorizing damaged segment of colon. (Antimesenteric colostomy).
B. Temporary colostomy showing complete trans-section of colon for defunctionalizing injured distal colon.

anastomosis was soon recognized. Thereafter, in the remaining cases, the bowel was resected using Doyen clamps with the electric cautery and an open end-to-end anastomosis performed (Table III). After the anastomosis was completed, the defect in the mesentery was closed. The bowel was then replaced within the peritoneal cavity. Any adjacent small bowel denuded of serosa was repaired. In two cases, this entailed the resection and end-to-end anastomosis of a damaged segment of small intestine. Five grams of sulfanilamide was placed about the colon anastomosis before the abdomen was closed.

The abdominal wall was closed in layers, using catgut throughout, except for the skin, which was closed with interrupted black silk sutures. All cases were closed tightly without drainage. As a rule, after proper preparation, peritoneal contamination, which could result in peritonitis, was given little

consideration. It is evident, from this description of the operative procedure, that we pushed the usefulness of the technic of preoperative preparation of the colon with sulfaguanidine to the utmost by treating all colon operations as though they were clean surgery.

TABLE III

INTRAPERITONEAL LARGE BOWEL OPERATIVE PROCEDURES

Resection and anastomosis	42
Open technic	30
Closed technic	12
Resection and ileotransverse colostomy (open)	6
Transverse closure of antimesenteric colostomy	41
Transverse closure of colonic fistulae	19
Anaesthesia:	
Gas-oxygen-ether	70
Spinal	38
Total	108

The management of large bowel surgery as if it were clean surgery merits further emphasis. This may well be exemplified by citing a case of volvulous of the sigmoid, with obstruction, for which a colostomy had been performed overseas, subsequently admitted to our service. In our operative treatment of this case, the abdomen was first opened through an oblique incision in the left lower quadrant. Exploration revealed a markedly redundant loop of sigmoid, in the apex of which there was an antimesenteric colostomy. The incision in the left lower quadrant was then temporarily closed with towel clips. The colostomy, which had been established above the umbilicus, was then freed from the abdominal wall by our usual technic and dropped into the peritoneal cavity. This incision was then closed in layers. The abdomen was then reëntered through the initial incision in the left lower quadrant, through which the colostomy was now withdrawn and a resection of a segment of the sigmoid colon, 14 inches in length, bearing the colostomy stoma, was performed.

An open end-to-end anastomosis was then accomplished. The abdomen was closed without drainage. It is very apparent that during this extensive surgical procedure, in the face of an open colostomy which was freely manipulated and carried through the larger part of the peritoneal cavity, contamination was extensive and unavoidable, yet the postoperative course was entirely uneventful and without the slightest evidence of peritoneal irritation.

Postoperative Management: One of the most essential factors in the postoperative care of these cases was oral starvation. The patients were given nothing by mouth the day of operation. They received 5% glucose in saline, or 10% glucose in distilled water, as indicated.

On the first postoperative day, the patient was allowed water, tea and ginger ale. Sulfadiazine was started orally, beginning with an initial dose of 2 grams and continuing with one gram every four hours, together with 2 grams of sodium bicarbonate. This was all the oral intake the patient was allowed for the first four to five postoperative days. His daily caloric, fluid and vitamin

requirements were met by intravenous therapy. Parenteral amino-acids were given to allow the patient 30 Gm. of protein daily. Vitamin K was administered parenterally in amounts of 2 mg., three times a day, for two days postoperatively. Vitamin C and B-complex were administered in adequate amounts.

By following this regimen, the amount of postoperative distention was kept to a minimum. Wangensteen decompression was used postoperatively in only ten cases, or 9%.

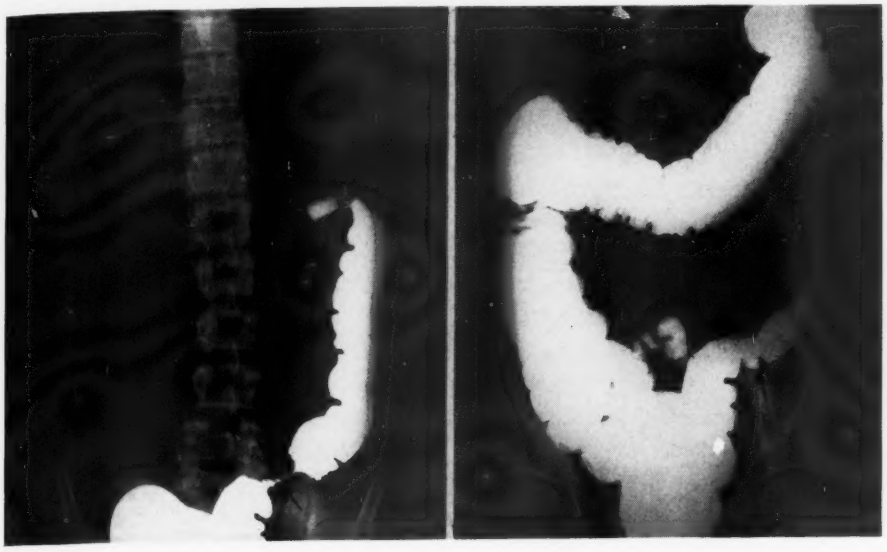

FIG. 14-A FIG. 14-B

FIG. 14-A.—Barium enema performed 18 days after intraperitoneal anastomosis. Arrows point to anastomosis.
B. Barium enema of same patient 28 days after operation, showing marked dilatation in ten days.

The significance of oral starvation may be more fully appreciated if it is remembered that the most significant factor in intestinal distention is swallowed air. Wangensteen[18] concluded that about 68% of gas in the intestine in obstruction has its origin in swallowed air; about 23% from nitrogen in the blood passing into the intestine; and that less than 10% of all the gas forms from putrefaction and fermentation. It has been observed that the amount of swallowed air taken with fluids is minimal compared with that swallowed with solid foods.

Oil retention enemata were started on the 2nd postoperative day and continued daily. By the 2nd postoperative day, practically all patients were passing flatus per rectum.

On the 5th or 6th postoperative day, jello, bouillon and toast were added to the patient's oral intake. From this point on, the diet was gradually built up to a soft, low residue diet by adding one item of food at a time until the full diet was reached by the 14th postoperative day.

The patient's dressing was not disturbed until the 7th postoperative day, at which time the wound, as a rule, was found clean and well-healed. Sutures were removed on the 10th postoperative day. The patient was allowed out of bed on the 14th postoperative day, at which time the wound was again inspected and the dressing discarded.

Sulfadiazine, which had been started on the 1st postoperative day, was continued until the 14th day. In this respect, our postoperative management differs radically from other surgeons who have been doing colon surgery and placing reliance on preoperative preparation with the sulfa drugs of low absorption. Most reports by these men have shown that they continued with a nonabsorbable sulfonamide in the postoperative period. In our regimen, an absorbable sulfonamide—sulfadiazine—was used postoperatively because it was felt that maintenance of a high sulfa level in all the tissues is of more importance during this period than merely decreasing the intestinal flora.

Postoperative laboratory work included blood count, and sulfa level every other day; and daily urine analysis. Plasma proteins were checked as indicated.

Two cases which showed evidence of localized peritonitis were given streptomycin, with gratifying results.

A re-check barium enema was obtained four weeks after operation. An anastomosis measuring 1 cm. or more at this time was considered adequate. In a few instances, a barium enema was obtained on the 18th postoperative day. This was usually found to show a narrowed anastomosis which dilated unbelievably in the next ten days (Fig. 14).

All patients in this series showed an adequate functional anastomosis and were symptom-free at the time of their discharge.

RESULTS

Our results were summarized in Table IV. In all, 92 cases with colostomies or fecal fistulae were closed. Ninety of these were performed for wounds of the colon and rectum, two for other reasons. Three other nonbattle casualties had resections and ileocolostomies performed, also using the open intraperitoneal technic. A total of 108 large bowel operations were performed. No fatalities occurred in this series. All cases showed satisfactory bowel function upon discharge. The complications were few and remediable.

Fecal fistulae developed in three cases. Two of these closed spontaneously within ten days. Only one of these three cases had a persistent fistula, requiring operation. Therefore, complicating fecal fistulae requiring surgical correction occurred in only one case, or an incidence of 0.9%. There were nine cases of wound infection, including the three fistulae mentioned above, or 8.4%. Four cases developed a ventral hernia at the site of closure. These were cases where the colostomy had been exteriorized through a large wound which showed a defect in the abdominal wall at time of closure. There was clinical evidence of a localized peritonitis in two cases, or 1.8%. Neither of these cases developed fecal fistulae, and their signs and symptoms of peritoneal irritation cleared within four to five days.

TABLE IV

RESULTS—OBTAINED IN 108 INTRAPERITONEAL COLON OPERATIONS

	No. of Cases	Per Cent
Total anastomoses and closures	108	
Excellent results (determined by barium enema)	102	94.4
Adequate result	6	5.6
Bowel function:		
Normal	106	98.1
Adequate	2	1.9
Wound infections (including fecal fistulae)	9	8.3
Fecal fistulae	3	2.7
Spontaneous closure (within 10 days)	2	1.8
Requiring surgical closure	1	0.9
Localized peritonitis	2	1.8
Ventral hernia	4	3.7
Mortality	0	0.0

These results compare most favorably with the results of the few other groups reporting similar work.

Dixon and Benson[19] reported 102 cases of colostomy closure. Their operative technic was not exactly similar to ours, although they opened the peritoneal cavity to free the limbs of the spur, they did not drop the loop back into the free peritoneal cavity in most of the cases. They reported fecal fistulae in 2% of 102 cases, and wound infection in 13%. They used subcutaneous drainage.

Colonel C. H. Keene,[20] at Lovell General Hospital, as reported by Poth,[11] in June, 1944, in a smaller series of 50 cases, had no fecal fistulae. In Keene's own earlier report it appeared that his technic was nearly the same as ours, except that he did not close the skin for 48 hours postoperatively.

In marked contrast to these excellent results are those reported by Shallow, Eger and Tourish,[21] who used an extraperitoneal closure. They recently reported on 75 cases of colostomy closure, in which fecal fistulae developed in 13.3%.

Pilcher and Nadeau[22] reported on 15 extraperitoneal closures of temporary colostomies for war wounds. Their cases developed fecal fistulae in 6.6%.

Most surgeons who favor extraperitoneal closure stress the comfortable postoperative course of their patients, usually likening their convalescence to that of a postoperative appendicectomy or herniorrhaphy. The same comparison is valid in this series. All but five of our patients were out of bed on the 14th postoperative day. The great majority needed no analgesics after the 5th postoperative day. All but three of these patients left the hospital on a 30-day furlough four weeks after operation, unless requiring plastic repair of the abdominal wall or treatment for unrelated conditions. Following their return from this furlough they were reëxamined and discharged from the hospital. Re-check barium enema at the time of discharge revealed that all but two had an anastomosis measuring over 1.5 cm. in diameter (Fig. 15). These two cases were asymptomatic and had satisfactory bowel function. The re-

maining 95 patients showed excellent anastomoses on barium enema, all were symptom-free and had normal bowel function at the time of discharge.

DISCUSSION—APPLICATION TO CIVILIAN SURGERY

As previously stated, the first milestone in modern colon surgery was the work of Heinecke, Block, Paul and Mikulicz. The development of the extraperitoneal resection allowed surgeons, for the first time, to attack disease of the colon with a degree of safety.

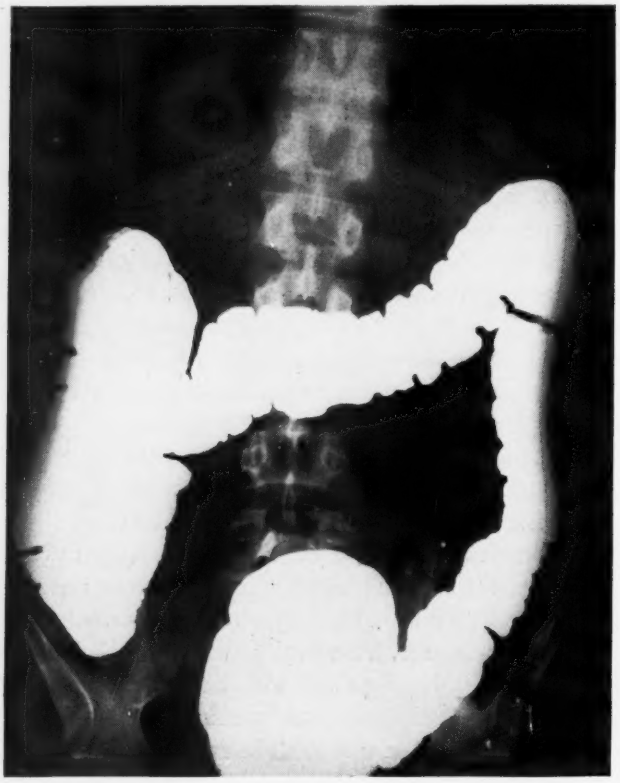

FIG. 15.—Postoperative barium enema following intraperitoneal anastomosis showing excellent result at time of discharge. Arrows indicate site of anastomosis.

The next advance in surgery of the large bowel was the development by Rankin[23] of the obstructive resection. By use of this technic the segment of colon containing the tumor, its entire mesentery and all involved nodes, could be removed at the initial operation. This accomplished a far more thorough eradication of the disease and resulted in a higher percentage of cures.

The third milestone in modern colon surgery was the development of the principle of defunctionalization. No discussion of colon surgery would be complete without reference to the work of Sir Hugh Devine.[24] In 1939, his article on defunctionalization of the colon was published in this country. In the same article, he described a somewhat different method of performing a

colostomy. Entirely too much emphasis has been placed on Devine's technic of performing a colostomy. The principle of defunctionalization was the important phase of the work. This principle, although realized in part by many surgeons, had never been completely grasped up to that time.

FIG. 16-A

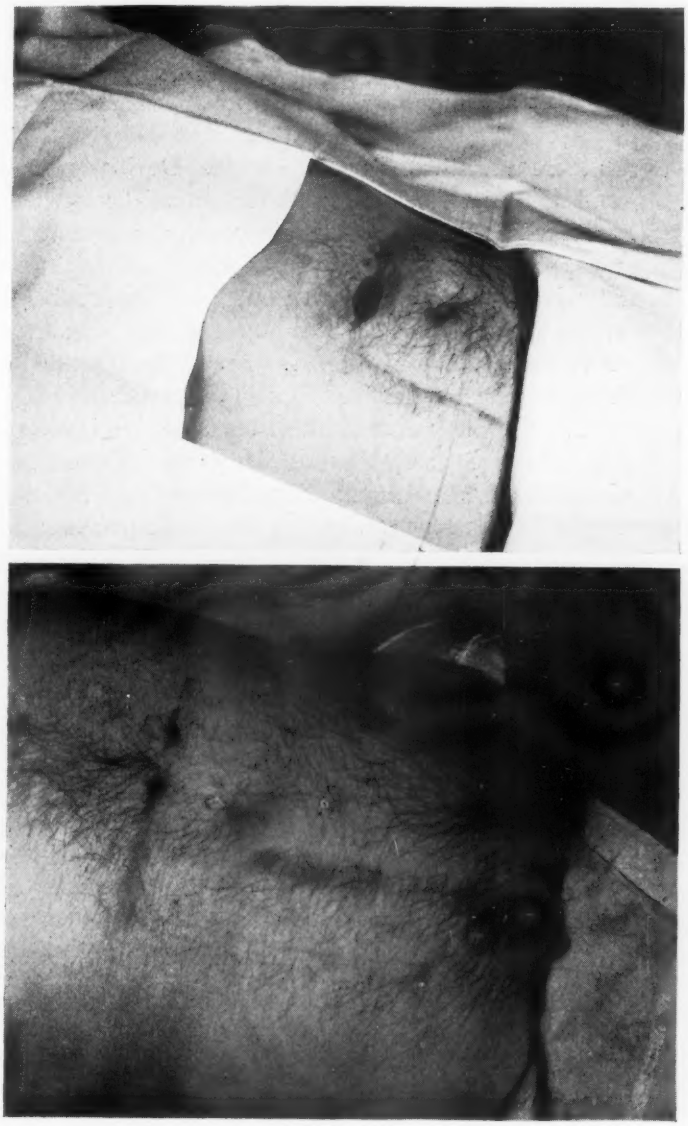

FIG. 16-B

FIG. 16-A.—A Devine-type colostomy performed to defunction distal large bowel with rectal perforation.
B. Same patient following closure of colostomy by intraperitoneal anastomosis.

Next to the contribution of the nonabsorbable sulfa drug, defunctionalization is the outstanding advance in colon surgery in the last half century. The principle of defunctionalization was proven of value in this war, time and again. In many cases who had extensive damage to the distal colon and rectum, which could not be exteriorized, a proximal defunctioning colostomy frequently saved the patient's life, reduced the morbidity, and made later surgical repair easier. Frequently, these distal lesions had completely healed by the time the patient had arrived in the United States. It was thus possible to close the colostomy shortly after admission. Of this principle there can be very little criticism. However, there is much to criticize in the so-called Devine colostomy (Fig. 16).

In this series there were three patients who had Devine-type colostomies. First, let it be said that these functioned satisfactorily. The Devine colostomy can be closed by intraperitoneal resection and anastomosis almost as easily as any other colostomy, but it has several disadvantages.

Babcock and Bacon[16] listed the disadvantages of the Devine colostomy, although they apparently failed to grasp the importance of defunctionalization. They stressed the danger of the Devine colostomy when the transverse colon is tense and thinned by distention. There is also the possibility of perforating the bowel when suturing the limbs of the loop under similar conditions of distention. Contamination of the peritoneal cavity and subcutaneous fat when the bowel is divided is also a danger. They also pointed out that the two stomata do not close spontaneously following crushing of the spur, as Devine claimed usually happened, but frequently needed an extensive surgical procedure to close.

Berman,[25] in addition to the above objections to the Devine colostomy, pointed out that the Devine procedure is fairly lengthy. In a completely obstructed, debilitated individual it may be more than the patient can stand. After the establishment of the Devine colostomy later surgery on the transverse colon is extremely difficult.

The Devine colostomy, notwithstanding its unusual features, closed in the usual way with the Devine or Oschner clamp, has all the disadvantages of the ordinary extraperitoneal closure. It leaves a loop of bowel permanently attached to the abdominal wall, with subsequent danger of obstruction, abdominal discomfort and development of ventral hernia. This series amply illustrated that the well set up double-barrelled colostomy with complete transsection of the bowel adequately defunctioned the distal colon. The technic which the authors used was to exteriorize a loop of bowel through a 9-cm. incision, suturing one limb in either angle of the incision, and suturing the abdominal wall, including about 4 cm. of skin between. Either this colostomy or the typical Devine colostomy can be easily closed by the technic of intraperitoneal anastomosis.

The work initiated by Firor on the use of the nonabsorbable sulfonamides in colon surgery represents the fourth, latest and greatest milestone. Since his initial report, it has been demonstrated repeatedly that the relatively non-

absorbable sulfonamide compounds alter and decrease the bacterial flora of the intestinal tract. The use of this bacteriostatic preparation of the bowel has enormously increased the scope of colon surgery.

Allen[12] has reported on the successful use of sulfasuxidine and sulfathaladine in performing colon surgery, including open anastomoses.

Archer and Lehman[13] reported 36 successful operations performed upon the colon using sulfasuxidine. They reported one death.

The excellent report by Dixon and Benson,[19] similar in many ways to our own work, has already been mentioned.

In 1945, Behrend[26] stated that the use of sulfonamide preparation of the colon has allowed him to practically eliminate the use of the Paul-Mikulicz procedure.

Despite these reports, many excellent surgeons still prefer two-stage, extraperitoneal procedures. In June, 1944, Cattell[27] stated that he considered intraperitoneal anastomosis the greatest hazard to colon surgery and felt that it was unnecessary.

It would seem, however, that a rational approach to the problems of colon surgery at the present time calls for a utilization of all the technics available to the surgeon. There will undoubtedly be some cases in which an obstructive resection will be the procedure of choice. In other cases, a period of defunctionalization will be the best solution to the problem, but undoubtedly, in the majority of cases, preparation with sulfonamides and the performance of resection and primary anastomosis will be the procedure of choice.

In applying the experiences gained in performing colon surgery on battle casualties, several procedures of value should be stressed.

In the occasional case of trauma to the colon encountered in peace-time, the same technic should be followed that has proven so successful during the war. A temporary colostomy should be performed without hesitation.

In penetrating injuries to the rectum a defunctioning colostomy should be performed. The same procedure will often be found of value in extensive repair of the anal sphincter and in plastic operations on the perineum.

The treatment of persistent rectovesical fistula may also be materially facilitated by the performance of a defunctioning colostomy.

In the treatment of complete obstruction of the large intestine, as by a carcinomatous lesion, a defunctioning colostomy performed before primary resection and anastomosis may frequently be the treatment of choice.

Colostomies, in general, should be closed by intraperitoneal anastomosis.

In this presentation certain modifications in the pre- and postoperative management and the surgical technic described are important, and are contributions of value in colon surgery. Although no major innovation has been described, we have gone further in demonstrating the singular efficacy of preoperative preparation with the nonabsorbable sulfonamides and the use of primary large bowel intraperitoneal anastomosis. We have pushed the usefulness of this technic to the utmost by treating all colon operations as though they were clean surgery from start to finish.

In conclusion, it should be stressed that the additional safety produced by the use of the nonabsorbable sulfonamides does not excuse the surgeon from continuing to exercise excellent surgical judgment and technic. The patient should be worked-up as thoroughly and prepared as carefully for operation as before. During the operation, meticulous dissection, careful hemostasis and gentle handling of tissues are as important as ever. In brief, the use of sulfonamides is not a substitute for surgical training.

SUMMARY

The problems of definitive surgery of the large bowel following war wounds have been presented. The mandatory use of a temporary colostomy, as directed by the Surgeon-General, was of utmost importance in lowering the mortality rate in wounds of the large bowel, anus and perineum.

The problems confronting the surgeons in Army General Hospitals in the United States engaged in reparative surgery of the large bowel have been described.

Consideration has been given to the repair of all types of colostomies, including multiple colostomies, wounds with marked loss of substance of the colon, fecal fistulae, trans-sacral perforations of the rectum, rectovesicocutaneous fistulae, and lacerations of the anal sphincter. The methods of repair for each have been indicated.

The problem of closure of colostomy has been discussed at length. The disadvantages of the so-called Paul-Mikulicz closure have been cited. Two cases of leiomyomata of the colon, developing at the site of a spur, have been reported. The advantages of intraperitoneal closure following preparation with sulfaguanidine have been presented. All our cases were treated by this method.

Preoperative preparation consisted of sulfaguanidine therapy, dietary regulation and daily irrigations of the colon.

Our operative technic included the following steps: The bowel was dissected completely free from the abdominal wall, thus entering the peritoneal cavity. An open anastomosis was performed, using a two-layer closure, the inner of continuous catgut, the outer of interrupted black silk. The bowel was replaced within the peritoneal cavity and sulfanilamide placed about the site of anastomosis. The abdomen was closed without drainage.

Postoperatively, the patients were treated by oral starvation, parenteral feeding, and oral administration of sulfadiazine. This last step is at variance with the procedure followed by other groups reporting the use of the nonabsorbable sulfonamides in colon surgery. Other groups have continued with the use of sulfasuxidine postoperatively, whereas we feel that the use of the absorbable sulfadiazine is preferable.

The results obtained in a series of 108 colon operations by this method are recorded. Fecal fistulae requiring surgical correction developed in 0.9% of the cases, and wound infection in 8.4%, including the fecal fistulae. Satisfactory bowel function was obtained in every case.

The importance of the principle of defunctioning the colon in certain cases has been stressed. The Devine colostomy has been criticized. The application of this work to civilian surgery has been considered. Preoperative preparation of patients with the nonabsorbable sulfonamides has made primary resection and anastomosis of the colon as safe as staged operations. The use of this technic has greatly increased the ability of the surgeon to eradicate colonic disease.

In this series a selected technic of preparation for and management of colon surgery, which differs in several important respects from routines reported by other surgeons, was employed. We tested the usefulness of this technic to the utmost by successfully treating all our large bowel cases as clean surgical procedures.

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EARLY AMBULATION IN ABDOMINAL SURGERY*

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EARLY AMBULATION in abdominal surgery is not a new procedure. It dates from a paper of Ries[1], in 1899. It is really as old as abdominal surgery, however, for Ephriam McDowell after the first ovariotomy on Jane Todd Crawford found her up and making her bed on the fifth postoperative day. The method found rather wide acceptance in European clinics,[2-4-13-14-16-20-21-23-27] but made no substantial progress in this country until the last six years. Recent reviews by Leithauser[35] and Newburger[36] and articles by Powers,[45] Schafer and Dragstedt,[51] and Elman,[42] as well as others,[31-32-38-40-41-42-48-49-50-56-61-62-63-65] have focussed attention on the subject. Nevertheless, there still persists a certain deep-rooted scepticism.

On examining the issue, it is apparent that the chief purpose of bed rest following abdominal surgery is to put the affected parts at rest. This is based on the conviction that inactivity is necessary for optimal wound healing. To secure this advantage it is necessary to accept the disadvantage of prolonged bed rest. Much attention has been directed at various physiologic aspects of the problem. In the recumbent position there is a decrease in vital capacity, and this is further augmented after abdominal operations[54] by a decrease in diaphragmatic function and a relative fixation of the diaphragm in a high position. Moreover, the horizontal position[55] greatly decreases the efficiency of the cough reflex. Under such circumstances some degree of atelectasis is inevitable. The influence of atelectasis, and its amelioration by early ambulation has been studied by Schafer and Dragstedt.[51] They approached the problem by comparing the postoperative temperature curves of 40 early-rising patients, and 100 traditionally bed-confined patients. In practically every instance the early risers had a lower temperature elevation and resumed a normal temperature level sooner than did the bed-confined patients. The assumption of the standing position and the downward pull of the abdominal contents lowers the diaphragm and increases the efficiency of the cough reflex. Coughing in the standing position will almost invariably expel the mucus and aerate the collapsed areas.

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Leithauser[35] has shown that with early rising the vital capacity returns to normal in half the time required by the bed-confined postoperative patients.

Backer-Grondahl[53] followed the spirometric curve of 24 patients upon whom gastric resection was performed for ulcer and found that in the early risers the spirometric curve returned to normal much sooner. His pulmonary complications in a large series were reduced to one-third of their former frequency. In Russia, Kimbarovskiy[20] decreased pulmonary complications from both gynecologic and gastric operations to approximately one-tenth through early rising. In this country a reduction in pulmonary complications has been noted by practically all who have considered the subject[33-35-44-45-51-52-61].

In the uncomplicated postoperative state there is an impairment of the circulatory reflexes necessary to the maintenance of the erect position. This results in cerebral anemia, with its familiar symptoms of faintness, giddiness, visual disturbances, palpitation and deepened respiration. The physiologic mechanisms involved in this syndrome are complex and have been studied extensively as a part of the war program on convalescence and rehabilitation. Among them are a diminished cardiac output,[57-58-59-60] a venous pressure deficit, a blood volume deficit and a decrease in the reserve of the venopressor mechanism. Among the prime causes of this physiologic disturbance is recumbency. The longer it persists, the slower the convalescence. Early resumption of the upright position produces a rapid return of the circulation to normal and is the secret of early postoperative fitness.

A diminished venous return and stasis in the deep veins of the leg are of prime importance in the development of postoperative thrombo-embolic phenomena. There are other elements to be considered, however, such as avoidance of trauma to veins, infection, alterations in the blood, as well as climatic and seasonal influences. Thrombo-embolism starts early, and for ambulation to be effective it must be early and active, that is, within the first 24 hours. In any series of cases there are some in which this cannot be accomplished. For this reason, early ambulation cannot entirely eliminate thrombo-embolic disease. The extensive literature[8-24-25-29-30-35-37-39-44-45-47-61-62-64] on this subject indicates that it probably reduces its incidence. This conclusion may be debatable, however, and final judgment must rest on a statistical analysis of controlled material.

The fear of faulty wound healing is the greatest deterrent to the acceptance of early ambulation. All authors are clear and definite that wound-healing is not impaired and there are many suggestions that it is improved. Ries[1] says: " . . . and I have yet to see the first hernia." Leithauser[33] had no dehiscence or postoperative hernia in 436 cases. In his later report,[35] dehiscence, incisional hernia and recurrences following herniorrhaphy were not more frequent after early rising. There was no instance of eventration in the 900 cases. In 462 abdominal incisions Nelson[43] had three partial disruptions, two of which occurred in patients whose wounds had been closed

with catgut and for whom early ambulation had not been authorized. Powers[45] allowed 39 herniae to rise early, and none recurred. In 39 controls treated by the traditional method of bed rest there were two recurrences. Ashkins[47] noted one bulging cholecystectomy wound and one weak scar, without protrusion, in 823 cases; Schafer and Dragstedt[51] in 102 cases had one eventration and two postoperative herniae. Elman[52] had no wound disruptions in 79 cases, but noted three in his control group. Many others testify in the same vein.[3, 5, 6, 7, 9, 10, 11, 12, 15, 17, 18, 19, 22, 26, 28]

From an experimental point of view, Newburger[36] produced standardized celiotomy wounds in rats and at intervals of 3–5–10 days the strength of the wounds was determined in animals which were kept at rest and in others which were exercised. Exercise rather than immobilization was found to hasten the increase in tissue strength of the experimental abdominal incision.

The Russian, Kimbarovskiy[29] studied wounds in dogs in the ambulant state and dogs forced into the reclining position by means of plaster encasements. In the restricted animal he concluded there was a decrease in fibroplasia.

The experience and data presented in this paper cover all cases admitted to the Surgical Service at the Brooke General Hospital, Fort Sam Houston, Texas, during the period September 1, 1943 to August 1, 1945. This was one of the larger Army General Hospitals and was situated on a permanent post. The material was predominantly military but there is included a very sizable number of veterans, dependents and retired personnel. The plan of early ambulation in this hospital was inaugurated by Brigadier General James Bethea during his tour as Chief of the Surgical Service. He was succeeded by Doctor J. M. Foster who continued these policies until he was relieved on the activation of the Colorado Unit.

All cases were under our direct supervision or personal care. The Service was so arranged that each case was seen each day by one of us during the immediate postoperative period. All were carefully examined on discharge. The data were obtained from the statistical records of the Surgical Service and from various personal notes and memoranda.

In all, there were 2827 abdominal cases. Nine hundred and nineteen of these were some variety of hernia. All herniae were treated by early ambulation from September 1, 1942 to July 13, 1943. During this period the policy was highly satisfactory and no ill effects were noted. Only one recurrence was noted at the Hospital. Two others were reported by letter. The exact date of recurrence in these cases can never be determined. Certainly, none recurred within six weeks after operation. There were no wound complications attributable to the policy. It is felt, but not known, that the eventual percentage of recurrences would be considered satisfactory. The policy of early ambulation in the treatment of inguinal hernia was discontinued by the Surgeon-General in a directive dated July 13, 1943.

The remaining 1908 cases comprised a representative group of abdominal cases.

Unless there were specific contraindications, such as shock, extreme debility, severe generalized peritonitis or an insecure wound, all cases were mobilized on the first postoperative day. The procedure was generally well-liked and accepted by all classes of patients. From the general point of view it was obvious that the morale of these patients was excellent and the effect of this on the preoperative cases was to remove much of the dread and fear of surgery.

There was a notable absence of bladder and bowel inertia and the problem of nursing was greatly simplified. After three to four days the average patient was pretty well able to look after himself and even to wait on the more recently operated upon. We have no record of the number of minor wound complications. Major wound complications were notable only by their absence.

It is definite that there was but one eventration. This occurred in an obese individual with intractable hiccough. There are records of four postoperative herniae — one following hysterectomy, one after the closure of a colostomy; one following nephrectomy and one at the site of a marsupialized pancreatic cyst.

A few mild cases of superficial thrombophlebitis were seen, and most were attributed to the practice of using a foot vein for the intra-operative administration of fluids. There were no cases of femoral or iliac thrombophlebitis. Two patients died from pulmonary embolism. One of these occurred 67 days postoperatively in a malnourished individual who had a stormy convalescence after a posterior gastro-enterostomy for duodenal ulcer. There is some evidence that this was related to an infusion of amigen into a leg vein. The other occurred in a young veteran with an inoperable retroperitoneal tumor. He was ambulant on the first postoperative day and had a normal course until he suddenly died on the tenth postoperative day with the classic symptoms of embolism. An autopsy was refused.

In conclusion, our experience, as well as the cumulative recorded experience of many surgeons, testifies to the physiologic soundness of early postoperative ambulation. It is a proved procedure of great benefit to patients and is deserving of a much wider employment.

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DISCUSSION.—DR. BRADLEY L. COLEY, New York City: The subject of early rising after surgical operations has been of great interest to me, and I feel we should be grateful to Doctor Burch for having presented his views and his experience while he was Chief of the Surgical Service at Brooke General Hospital. I can say, without hesitation, that his conclusions as to the advantages of early ambulation were borne out by the experience of other surgeons in the Eighth Service Command, where it was my privilege to serve for nearly three years. I should like to take up just one phase of the subject; namely, the effect of early ambulation on reduction of the incidence of phlebothrombosis and pulmonary embolism.

In the autumn of 1944 we surveyed the large Station, Regional and General Hospitals in the Eighth Service Command and collected the cases which had accumulated up to that time. Thirty hospitals reported a total of 153 instances of phlebothrombosis, with 54 pulmonary embolisms and nine deaths. In none of these cases had the patient been an early riser. Later, I did learn of an appendix patient allowed up early who developed a nonfatal embolism on the 14th day after operation.

While it seems clear that ambulation will not eliminate this dreaded complication of surgery, it is our opinion that it should do much to reduce its frequency.

Doctor Burch spoke of the directive which prevented us from adopting early ambulation in hernia patients. For the past six months on Dr. Carl Burdick's service at the Hospital for Special Surgery, we have made it a rule to allow all our hernia patients out of bed on the day after the operation. These cases include large incisional, umbilical, recurrent inguinal and femoral herniae. When sufficient time has elapsed to permit us to draw conclusions we will report our experience. Suffice it to say, however, that the immediate results have been gratifying to us and to the patients. Were we not using nonabsorbable suture material throughout, we would not have the assurance that the early rising of these patients is an entirely safe procedure.

A word of caution is timely. The mere fact that the patient with an abdominal operation is allowed to leave his bed and walk about does not imply that his activities can be unrestricted. He must be cautioned as to what he can safely do and what he must avoid, lest he place undue strain on his as yet unhealed incision.

If early ambulation is practiced intelligently it seems that it is a sane, a safe and a beneficial method of postoperative management.

DR. HERMAN E. PEARSE, Rochester, N. Y.: About a year ago I had the privilege of visiting some hospitals in Texas with Colonel Burch, and at that time learned of his results. I was greatly impressed then, as I am now. The method was not unfamiliar, for some of you may remember that some time ago Doctor Morton advocated early ambulation in older patients. We must admit to a certain amount of mental lethargy in not adopting this for younger, healthier patients. The fear of wound disruption by early ambulation is a myth, handed down to us from the past. A wound may be disrupted by involuntary action such as coughing, sneezing, or vomiting or by pressure from distention. It is not disrupted by voluntary effort, for

a patient will not hurt himself. Any activity within the limits of comfort is safe. I am confident that venous complications begin soon after operation and that early ambulation alone will not be enough to prevent them. Early activity in bed must be added. In the first 24-hour period a patient is out of bed only a short time, so the percentage of time in bed, even with early ambulation, may permit venous stasis. If the patient is ventilated to shorten the period of unconsciousness from anesthesia, if he is not deeply narcotized, if he is turned in bed and has leg exercises at frequent intervals, then these, added to early ambulation will, I believe, eliminate many of the surgical complications we accept as inevitable to major abdominal surgery.

DR. JOHN C. BURCH, Nashville, Tenn. (closing): There are several practical points about the technic of early ambulation. Preoperatively, it is a good idea to explain the method and to instruct the patient to do three things on reacting; these are: (1) To take deep breaths even though it hurts; (2) to turn from side to side; and (3) to exercise the leg muscles frequently by flexing and extending the foot. In addition, the method of sitting a patient up in bed is demonstrated. The patient, lying on the side and with the feet dangling, is brought to the edge of the bed, then the backrest is gradually cranked up. When the patient overcomes the usual giddiness, the full sitting position can be assumed easily with only minimal discomfort. This should be done several times during the first postoperative day and the patient encouraged to get up later in the day. This is most easily done by using a footstool as a step-down. The pain is not severe and is about the same as in turning. Giddiness and weakness are almost universally noted, but are generally overcome by the fourth or fifth day when average patients can pretty well handle themselves.

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